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MARTINSDALE RESERVOIR

NORTH DAM and EAST DAM

MANUAL FOR OPERATION AND MAINTENANCE

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State Water Projects Bureau
Water Resources Division
Department of Natural Resources and Conservation
48 North Last Chance Gulch
P.O. Box 201601
Helena, MT 59620-1601

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PROJECT DESCRIPTION

OVERVIEW

The Martinsdale project consists of two dams (East Dam and North Dam) and a 23,348 acre-foot (af) reservoir. Both East and North Dams are located in Wheatland County with the reservoir being in Wheatland and Meagher Counties. Martinsdale Reservoir is located approximately 23 miles west of Harlowton and 34 miles east of White Sulphur Springs. The reservoir is located off of Highway 12 about 2.5 miles southeast to the town of Martinsdale (see Figures 1 and 2). Figure 3 provides a general layout and shows the location of the monitoring wells at the North Dam. Figure 4 provides a general layout and shows the location of the monitoring wells at the East Dam.

The dams are owned by the Montana Department of Natural Resources and Conservation (DNRC) and are managed by the State Water Projects Bureau (SWPB) of the DNRC. The Upper Musselshell Water Users Association (herein called the "association") operates and maintains the dam.

Water from the reservoir is primarily used for irrigation water supply. The reservoir is also used for water-based recreation.

SUPPLY CANAL

This off-stream reservoir is fed by a supply canal from the South Fork of the Musselshell River. The supply canal is 2.41 miles long and has a capacity of 408 cfs. Water can also be obtained from the North Fork of the Musselshell River which is diverted into the North Fork Diversion Canal (11.7 miles long, 105 cfs capacity) and conveyed to the South Fork of the Musselshell River above the supply canal to the reservoir.

EMBANKMENT

Both earthfill dams were completed in 1939. The North Dam is 91 feet high and 1,000 feet long and has the outlet works. The East Dam is 49 feet high and 1,550 feet long and has the primary spillway and the emergency spillway.

The design plans show the dam embankments to be zoned, with moderately thick upstream impervious sections, semi-impervious central sections, and gravelly downstream sections. The upper 1 foot of the embankment is composed of a gravelly fill for a road surface. There is no indicated provision in the design plans for overbuilding or camber to account for consolidation settlement.

OUTLET WORKS

The outlet works and a distribution canal are located at the North Dam. The outlet works consists of an inlet structure, a 60-inch diameter reinforced concrete pipe tunnel, a dry tower with a 54-inch butterfly operating gate valve and a 54-inch slide emergency gate valve, and an outlet structure. Control for the operating butterfly gate is at the top of the tower and control for the slide emergency gate is at the bottom of the tower. The outlet works will discharge 720 cubic feet per second (cfs) with the reservoir pool at the dam crest.

SPILLWAY

The primary spillway is located in the right abutment of the East Dam. The spillway is a concrete chute which is 10 feet wide at the top and tapers to 6 feet at the bottom. The spillway was rehabilitated in 1985 which consisted of replacing a portion of the chute walls and floor and placing drains under the floor and outside the walls.

The emergency spillway, located in the right abutment of the East Dam, was constructed in 1989. The earth and rock lined chute, located to the right (south) of the primary spillway, is 35 feet wide at the crest.

DRAINS

East Dam: The drawings for the dam show a toe drain that begins in each abutment and is joined at the toe and exits in a drain ditch below the toe of the dam. The end of the drainpipe has not been observed. There is water that flows down the drain ditch when the reservoir is at higher elevations.

There is a drain under the spillway floor slab that exits about halfway down the spillway, and a drain pipe located along the outside of the spillway sidewalls that exit into the spillway chute. The floor drain was replaced during the spillway rehabilitation in 1985. The sidewall drains were installed during the 1985 rehabilitation of the spillway.

North Dam: The drawings for the dam show a toe drain that begins in each abutment and is joined at the toe and exits in a drain ditch below the toe of the dam. During the rehabilitation work in 1985, a manhole was placed at the "T" in the toe drain and the pipe downstream from the manhole was replaced. A considerable amount of flow has been observed exiting from the drain since its replacement.

As part of the rehabilitation work in 1985, four horizontal wells were drilled into the left abutment to help control the seepage, and an interceptor drain was installed along the contact of the toe of the dam and the abutment. The horizontal wells and the interceptor drain exit into the upper left manhole, so they can be measured. An additional drain was installed in the left

abutment dam toe area by the upper left manhole in 1987. The seepage that is collected in the upper left manhole is piped into the center manhole where the flow is combined with the original toe drains and discharges into the drain ditch.

Additional drains were also installed in the right abutment during the rehabilitation work in 1985. The right abutment drain system consists of eight horizontal drains, an interceptor drain that extends out into the abutment area where seepage surfaced, and a blanket collector drain upstream from the right abutment manhole covering the area downstream from the horizontal wells. All of these drains in the right abutment flow into the right manhole where they can be measured. The seepage collected in the right manhole is piped through the right outlet wingwall. An additional drain was installed between the right manhole and the right outlet wingwall in 1987 to collect seepage that was surfacing in this area. A connection with this drain was made to the right abutment interceptor drain.

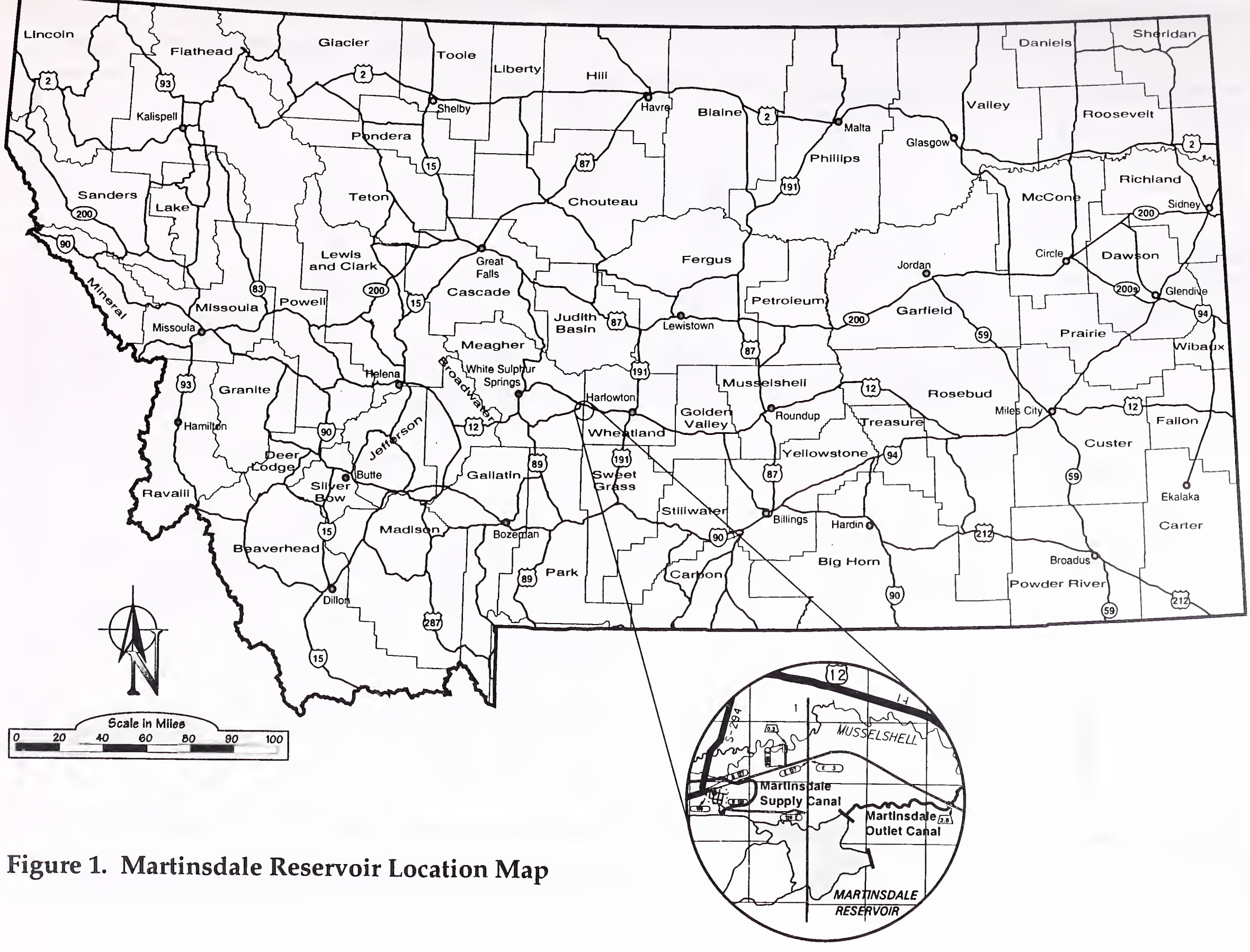

Figure 1. Martinsdale Reservoir Location Map

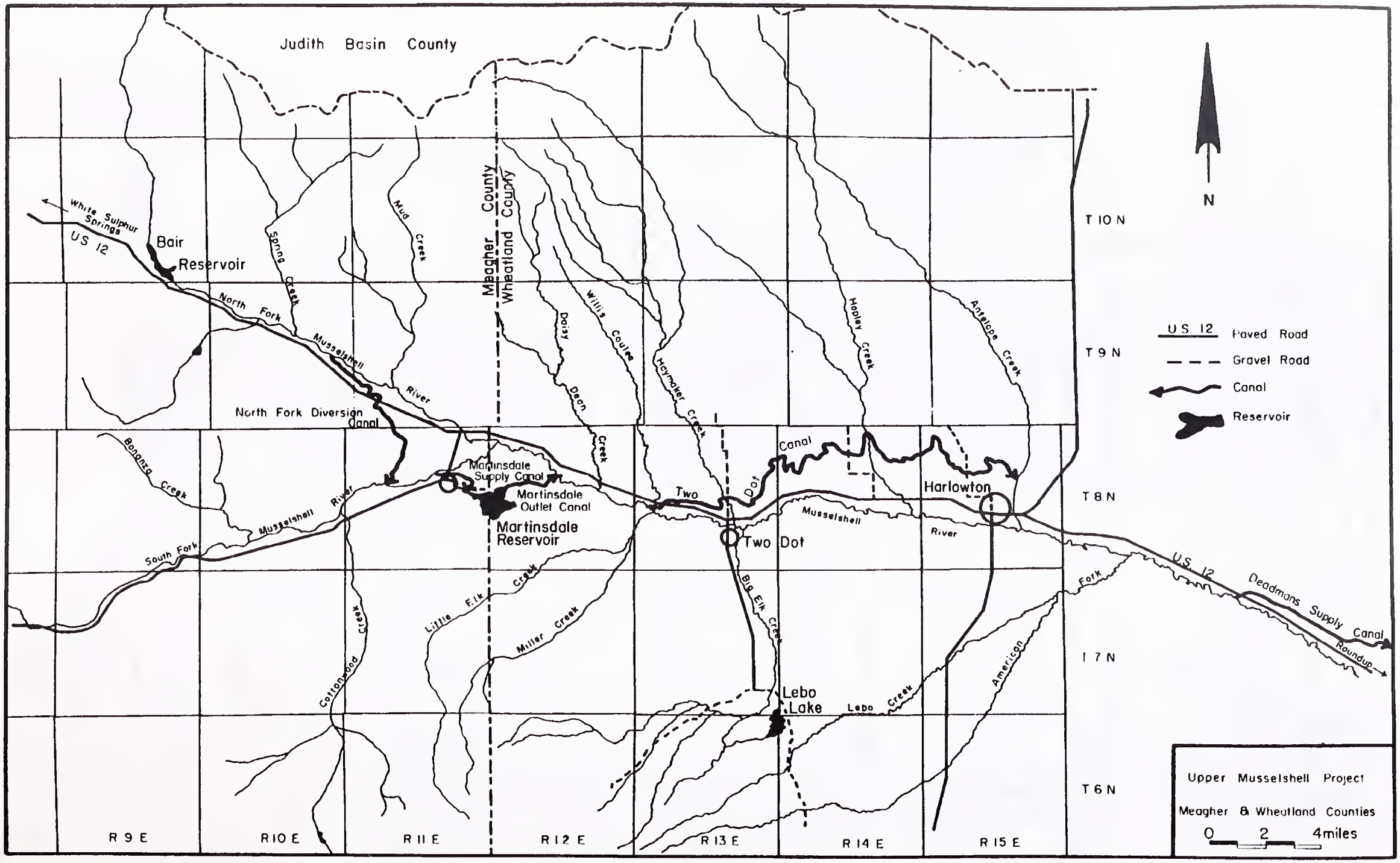

Figure 2. Martinsdale Project Map

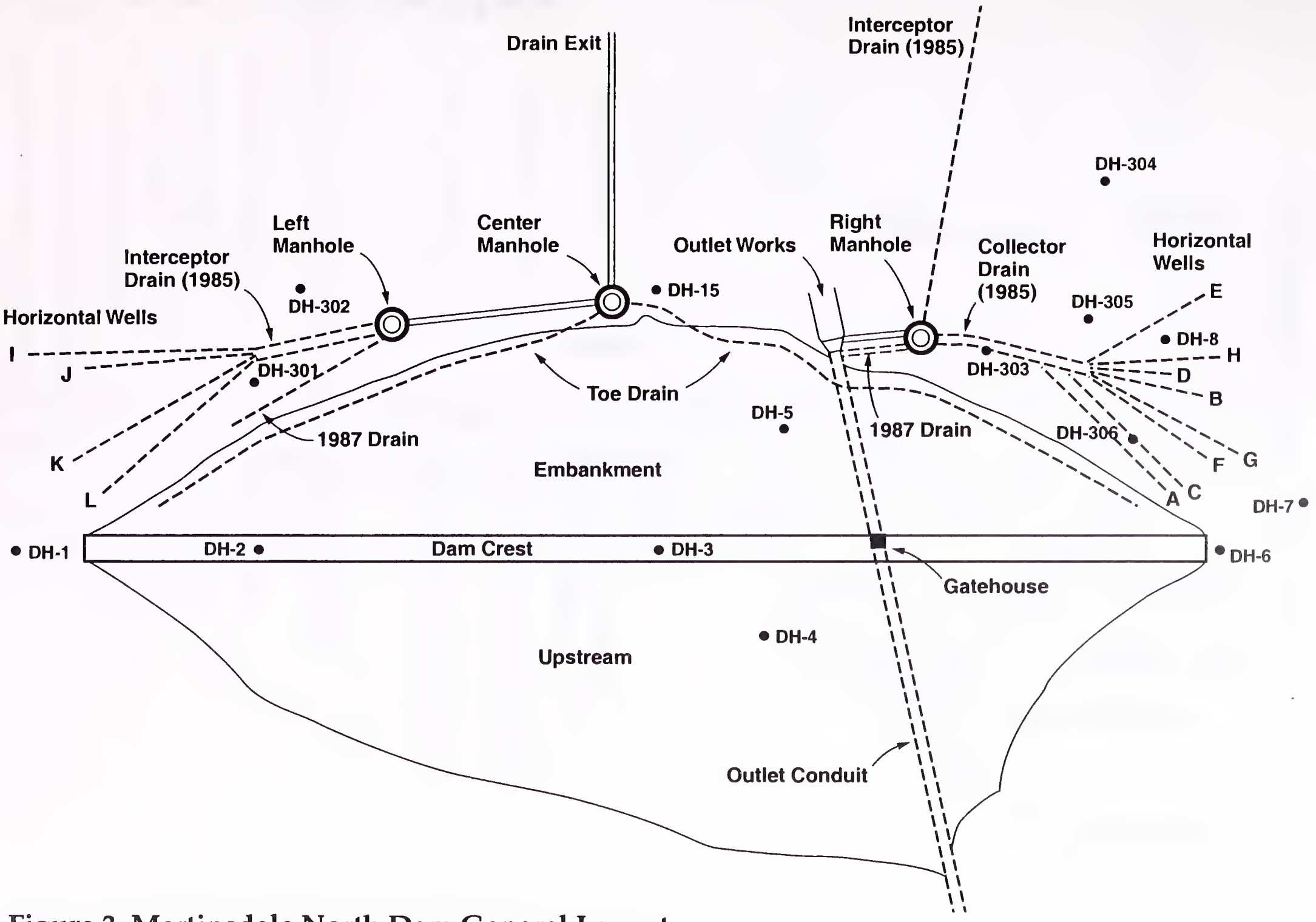

Figure 3. Martinsdale North Dam General Layout

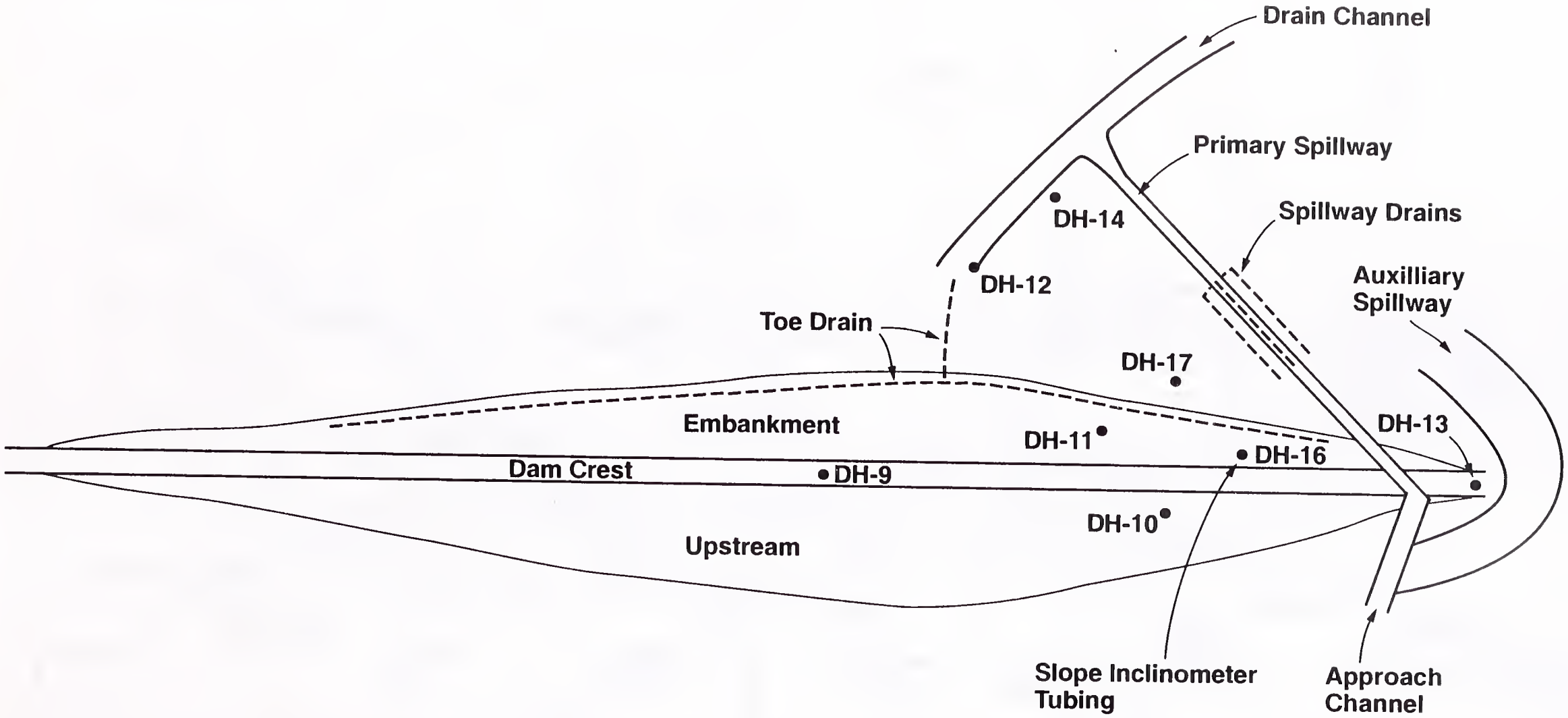

Figure 4. Martinsdale East Dam General Layout

STATISTICAL INFORMATION

1. General

a. Owner	Montana Department of Natural Resources and Conservation (DNRC)
b. Operator	Upper Musselshell Water Users Association
c. Location	Sections 17, 18 (North Dam), 19 and 20 (East Dam), Township 20 North, Range 17 West, MPM
d. North Dam	
Latitude	46.46°
Longitude	110.27°
East Dam	
Latitude	46.44°
Longitude	110.26°
e. County/State	Meagher and Wheatland County, Montana
f. Watershed Location	Tributary to the Musselshell River
g. USGS Quadrangle	Martinsdale, Montana (7.5 min.)

2. Principle Elevations (feet above mean sea level)

a. Dam Crest	4,792 feet
b. Emergency Spillway Crest	4,780.25 feet
c. Normal Full Pool	4,779.25 feet
d. Primary Spillway Crest	4,779.25 feet
e. Top of Inlet Structure	4,725.30 feet
f. Inlet Conduit Invert (design)	4,701 feet
g. Normal Tailwater (approx.)	4,704 feet
h. Outlet Conduit Invert (design)	4,699 feet

3. Reservoir

a. Length (approx.) (of maximum pool)	2.5 miles
b. Surface Area (at normal full pool)	985 acres
c. Drainage Area	15.7 square miles

4. Storage

a. Maximum Storage (pool at dam crest)	38,958 acre-feet
b. Active Storage (reservoir at spillway crest)	23,348 acre-feet
c. Maximum Surcharge (from spillway to dam crest)	15,610 are-feet

5. Hydrology

a. Inflow Design Flood	17,600 cfs Probable Maximum Flood (PMF) (HKM 1986)
b. 500-year Flood	3,270 cfs
c. 100-year Flood	2,420 cfs

6. Embankment (North Dam)

a. Type	Earthfill
b. Hydraulic Height	91 feet
c. Crest Length	1,000 feet
d. Crest Width	22.7 feet
e. Upstream Slope	1v on 2h upper 12 feet and 1v on 3h below
f. Downstream Slope	1v on 2h

7. Embankment (East Dam)

a. Type	Earthfill
b. Hydraulic Height	49 feet
c. Crest Length	1,550 feet
d. Crest Width	22.7 feet
e. Upstream Slope	1v on 2h, upper 12 feet and 1v on 3.0 below
f. Downstream Slope	1v on 2.h

8. Outlet Works (North Dam)

a. Type	Reinforced concrete pipe. The upstream 220 feet is a reinforced concrete pipe with a 3/8-inch thick steel liner, and the downstream portion is unlined reinforced concrete.
b. Size	60-inch diameter, cast-in-place concrete conduit
c. Length	Approximately 416 feet
d. Controls	Emergency gate -- manually operated 54-inch diameter slide gate with controls in bottom of tower. Operating gate -- manually operated 54-inch diameter butterfly valve with control at top of tower.
e. Capacity at Dam Crest (pool at dam crest)	720 cfs
f. Trashrack	Yes

9. Primary Spillway (East Dam)

a. Type	Concrete chute
b. Crest Width	10 feet, narrowing to 6 feet
c. Capacity (pool at dam crest)	1,320 cfs

10. Emergency Spillway (East Dam)

a. Type	Earth and rock lined chute
b. Crest Width	35 feet
c. Capacity (pool at dam crest)	5,770 cfs

11. Canals

a. Supply Canal	2.41 miles long 408 cfs capacity
b. Outlet Canal	2.57 miles long 333 cfs capacity

OPERATING PROCEDURES

The Upper Musselshell Water Users Association manages and operates the Musselshell Reservoir to provide an adequate supply of irrigation water to meet contracts with the water users without exceeding safe storage and flow levels.

DAM OPERATOR

The responsibility for the daily operation of the canals, dams, and reservoir rests with the association and the dam operator. The dam operator is generally authorized to operate the reservoir to meet the association's goal of providing an adequate supply of irrigation water to met contracts with water users without exceeding safe storage and flow levels. Specific responsibilities of the dam operator are as follows:

1. Operate the mechanical features of the outlet works.
2. Coordinate filling the reservoir and releasing the water.
3. Notifying the SWPB of any unusual occurrences, such as, vandalism, impending floods, excessive seepage, problems with the outlet, or if the spillway(s) are flowing.
4. Perform various maintenance tasks.
5. Maintain water level records and report findings to the SWPB.
6. Monitor weather conditions.
7. Monitor seepage.

Typically, the out-going dam operator, the association, and the SWPB train a new dam operator. The dam operator's training focuses on the mechanical operation of the gates, measurement of the storage level, measurement of the rate of water release, and record keeping. The outlet gates are operated manually with a hand crank.

The dam operator is normally available daily to observe the dams and perform operating functions during the times of rapid reservoir filling. During the remainder of the filling and irrigation seasons, the operator is at the dams three to five times per week. At other times of the year, the dam operator is available if needed.

Communication among the dam operator, the association, and the SWPB usually takes place by telephone. Although radio communications are not routinely available, during emergencies or unusual occurrences, radio communications may be established so the dam operator can speak directly with county authorities and with the SWPB **(see Martinsdale Dam Emergency Action Plan)**.

METHOD AND SCHEDULE OF OPERATION

The association's goal is to have the reservoir full before contract holder's start calling for water. The normal full pool elevation is 4,779.25 feet with 23,348 acre-feet of storage.

The supply canal is operated during winter as long as icing is not a problem. Even when icing does occur, some water continues to run through the canal under the ice. The supply canal is often clear of ice and running at capacity by March 1.

The date irrigation releases begin varies from year to year, with late April being the earliest. During typical years, releases begin around June 1 and end by mid-September. The water delivery contracts provide that water will be available to the users between the dates of May 1 and September 30. If water is available, water may be released outside the contract dates. The actual dates that releases begin and end depend on each year's climatological and hydrological conditions.

Maximum Operating Level: The reservoir should not be filled and operated above 4,779.25 feet (primary spillway crest). When reservoir pool levels exceed 4,779.25 feet, the drains at the North Dam are surcharged and exceed their design capacity.

Maximum Winter Storage: The maximum reservoir elevation for winter storage is 4,769.0 feet with 14,513 acre-feet of storage. This winter maximum helps prevent damage to the riprap and embankment from wind-driven waves and ice.

Minimum Winter Storage: The minimum reservoir elevation for winter storage is 4,735.0 feet with 1,093 acre-feet of storage. This winter minimum helps prevent ice damage to the inlet structure for the outlet works, minimizes water quality problems, and helps to maintain the fishery.

GATE OPERATION

With the reservoir pool at the dam crest, the capacity of the outlet works is 780 cfs. However, normal operation of the outlet works is constrained by the capacity of the outlet canal (333 cfs). If the outlet works are operated far in excess of the delivery canal's capacity, the canal and canal structures may be damaged.

The maximum gate opening for the operating gate is 27 inches. The maximum gate opening for the emergency gate is 54 inches. Openings in excess of this amount may damage the gate, gate frame, gate stem or the gate operating pedestal. These openings are measured on the exposed portion of the gate stem between the top of the pedestal and the bottom of the stop nut (or top of the gate stem if there is no stop nut).

The outlet works are to be used for controlling the release of irrigation water and not for providing emergency relief.

SPILLWAY

With the reservoir pool at the dam crest, the capacity of the primary spillway is 1,320 cfs and the capacity of the emergency spillway is 5,770 cfs. The crest of the auxiliary spillway is set one foot higher than the primary spillway crest so that it will operate at inflows greater than the 100-year flood event. The combination of the outlets works operating at 450 cfs, the primary spillway, and the emergency spillway will pass the peak outflow from a probable maximum flood (PMF) event with about 2.5 feet of freeboard. Rating tables for the primary and emergency spillways are included in Appendix A.

SAFE DRAWDOWN

The stability of the Martinsdale dams has been thoroughly investigated (HKM, 1982). It was determined that under a sudden drawdown condition, both embankments had a stability factor of safety that was in general compliance with dam safety guidelines. Therefore, it is anticipated that under normal or emergency operations, embankment stability is not a concern.

STORAGE DETERMINATION

Storage in the reservoir and the elevation of the reservoir surface are determined by taking a slope measurement. Measure in feet from the 0+00 pin which is located 25 feet down slope from the south east corner of the Department of Fish, Wildlife, and Parks (FW&P) toilet which is approximately 900 feet prior to the left (northwest) end of the dam. The slope pin alignment is

approximately 130° magnetic. The elevation of the reservoir surface and the storage can then be found using the Slope-Elevation-Storage Table in Appendix A.

WEATHER MONITORING

The dam operator monitors weather conditions through local weather forecasts and the National Weather Service (NWS).

If severe flooding is anticipated, the NWS Great Falls Office **(406-453-2081 or 406-453-4561)** should be contacted for information about the storm, such as the estimated storm intensity and duration, runoff duration (above base flow), and total flood volume of the storm.

INTERACTION WITH OTHER DAMS

Except for irrigation diversion dams, Fort Peck Dam is the next dam down stream of the Martinsdale dams. The safety of the irrigation diversion dams is not affected by the normal operation of the Martinsdale dams and would have no impacts on Fort Peck Reservoir. However, there are several small towns along the Musselshell River that would have some affects from the failure of one or both dams.

EMERGENCY

If it appears that either one or both of the Musselshell Dams is about to breach, or during emergency operations, the dam operator will initiate the **Martinsdale Dam Emergency Action Plan**.

INSPECTION AND MONITORING

The SWPB inspects the dams annually. Appendix B includes an example of a SWPB inspection report form. In addition to annual inspections, SWPB personnel will inspect the dams and reservoir during and after heavy runoff, severe rainstorms, and severe windstorms; during high storage periods; and after an earthquake. Both dams have monitoring wells.

STRUCTURAL FEATURES INSPECTION

Structural features include the dam embankment, outlet works, gatehouse, and spillways. The SWPB will inspect these structures annually as part of its inspection program. Items checked or noted include, but are not limited to:

1. Dam Embankment
   a. Erosion gullies on the faces
   b. Damage from burrowing animals or vegetation
   c. Displacement or loss of riprap protection
   d. Displacement of fill, sink holes, slumps, or other items
   e. Any seepage on downstream face or base of embankment
2. Outlet Works
   a. Any differential settlement or movement resulting in cracking of the conduit
   b. Erosion of the seals or concrete conduit by cavitation immediately downstream of the gates
   c. Seepage of water into the conduit
   d. Deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
   e. Operation of the gates through a full cycle
   f. Jet pump, for unobstructed operation
      (see drawing - Appendix E)

g. Corrosion of any metal

h. Lubrication and cleaning of the pedestals

i. Air vent for unobstructed flow

j. Plugging of the inlet structure with sediment

3. Gatehouse – Any damage or vandalism

4. Primary Spillway
   a. Erosion of the spillway channel

   b. Blockage of the approach

   c. Deterioration of concrete

   d. Drainage system for evidence of plugging

   e. Cracking or movement of concrete

   f. Silt deposits building a berm above the primary spillway crest, and wind blown sediment in the spillway

5. Emergency Spillway
   a. Erosion of the bottom and banks

   b. Silt deposits building a berm above the emergency spillway crest, and wind blown sediment in the spillway

6. Drainage System
   a. Settling or other damage to manholes

   b. Evidence of plugging with silt or other objects

   c. Settling or plugging of the drain pipes

RIPRAP INSPECTION

The riprap along the face of each dam and along the road beyond the right abutment on the reservoir side should be at least 30 inches thick. Immediately after the occurrence of high water, the riprap will be inspected and additional riprap added if needed.

EAST DAM EMBANKMENT MONITORING

Three monument points and one slope inclinometer tube are located on the down-stream slope of the East Dam embankment toward the right abutment. The monuments were placed when a "bulge" was discovered in the early 1980s. When it was determined that this bulge was merely a deposit of blow sand, it was decided that these points did not need to be monitored further. However, this area is inspected for cracking, slumping, bulging or spillway full of silt during regular inspections.

SEEPAGE

East Dam: Prior to the rehabilitation of the spillway in 1985, there were two seepage areas in the right abutment of the East Dam that were identified by HKM in the Martinsdale Reservoir Seepage Monitoring Program and Stability Analysis Report, December 1982. The COE Phase I Inspection Report, October 1980, identified "a considerable amount of water at the downstream toe of the East Dam. The COE Inspection is the only time that a "considerable" amount of water has been noted at the toe of the East Dam.

The two seepage areas in the right abutment area have not been observed since the rehabilitation of the spillway and installation of drains was completed in 1985. The drains in the spillway have flowing water when the reservoir is at higher elevations. The toe drain at the East Dam has also been observed flowing when the reservoir is at higher elevations.

North Dam: Seepage has always been present in both abutments of the North Dam since construction. In an attempt to reduce the seepage in the abutments, a total of 159 grout holes were drilled in 1940, 1941, 1962, and 1965. The 1965 grouting program resulted in a significant, but not complete, reduction in

seepage. Following the 1965 grouting program, seepage was observed in the left abutment, right abutment, at the toe by the drain exit, and flowing over the outlet walls. Since the addition of the drains in 1985 and 1987, the large seepage areas have not surfaced, but there is still seepage present at the toe of the dam above the toe drain outlet, in the left abutment area about 200 feet downstream from the dam, along the right side of the outlet channel, and above the right side of the outlet.

A sand boil was observed above the right side of the outlet in 1996. The sand boil is located almost above the drainpipe that was installed in 1987. A pipe and three shallow drive point piezometers were installed in the area to monitor the flow and the ground water elevation. The flow through the pipe and the appearance of the sand boil are dependent upon the reservoir elevation. The shallow piezometers also rise and fall with changes in the reservoir elevation.

MONITORING WELLS

Monitoring wells have been installed at both Martinsdale Dams. At the North Dam, nine wells were installed in 1982 -- seven observation wells and two Casagrande piezometers. In 1987, two additional drains were installed to control excessive seepage through the abutments, and six additional observation wells were installed to monitor the phreatic surface near the drains.

At the East Dam, eight wells were installed in 1982 -- five observation wells, two Casagrande piezometers, and one slope inclinometer tube.

The location of the wells are shown in Figure 3 and 4. Soil profiles of the drill holes and details as to how the wells were constructed are shown in Appendix D.

SEEPAGE MONITORING

The monitoring wells and toe drains at the North and East dams are observed and monitored by the Lewistown Regional Office, SWPB or dam operator during regular visits; and may be measured by the SWPB during annual inspections. The instruments are generally measured twice per month from May 1 to August 31, and once per month in March, April, September, and October. Measurements may be taken during the winter months (November, December, January, February) depending on weather conditions.

The slope inclinometer drill hole at the East Dam is measured with the slope inclinometer annually.

The drains exiting into the manholes at the North Dam are measured three to four times per year, during the period from April through September of each year. Increasing or decreasing seepage rates for a given pool elevation may be cause for concern or maintenance. If the rate is increasing, piping or stability problems may be developing in the embankment or the abutments. A decreasing rate would indicate a need for cleaning and maintenance of the drain system.

The following drain system items should be observed and measured:

a. Left Abutment Manhole
   - Flow from four horizontal drains (I, J, K, L)
   - Flow from 4 inch interceptor drain
   - Flow from 4 inch drain (added in 1987)

b. Right Abutment Manhole
   - Flow from eight horizontal drains (A, B, C, D, E, F, G, H)
   - Flow from 4 inch interceptor drain
   - Flow of combined right abutment drains discharging into the outlet works channel
   - Flow from the 1987 drain around the right abutment manhole discharging into the outlet works channel

c. Center Manhole
   - Flow of original toe drains (two 12-inch pipes)
   - Flow of combined left abutment drains (upper pipe and 6-inch at bottom

When measuring the manhole drain flows, check for water flowing into the manhole from around the outside of where each drain pipe enters the manhole. If water is flowing into the manhole from around the outside of a drain pipe, this means the grouting around the drain pipe is failing and needs repair

MAINTENANCE

The association is responsible for routine maintenance of the project. In addition, the SWPB may identify items that need maintenance or repair during the annual inspection.

ROUTINE MAINTENANCE

To protect the dams and keep them in good working order, the dam operator during regular visits to the dam will watch for and identify any potential maintenance requirements. As soon as a need is identified, the dam operator needs to schedule and perform the routine maintenance.

Items that may occasionally need attention include, but are not limited to:

1. *Lubrication of gate-operating mechanisms and keep the gate house and pedestals clean.*
2. *Debris or silt restricting the supply canals, spillway inlet or the outlet works.* Accumulated debris that could affect the operation of these appurtenances will be removed at once, with all debris removed at least annually.
3. *Erosion gullies on embankments.* Development of erosion gullies will be checked immediately. Gullies will be filled, compacted, and seeded. Particular attention will be paid to the abutment contact areas and the downstream faces.
4. *Rodent damage.* Rodents will be removed or destroyed, and any burrow holes should be filled immediately.
5. *Upstream slope riprap.* The upstream riprap of both dams normally will be observed annually, but may occasionally need repairs because of high water or wave action.
6. *Vegetative cover on downstream slopes.* Good vegetative cover will be maintained, but large brush will be removed.

7. *Noxious Weeds*. Noxious weeds on and around the dam embankments, reservoir, and canals should be sprayed on at least as annual basis.

8. *Cleaning spillway and outlet structure wall tops*. The spillway and outlet structure wall tops should be clear of any dirt, rocks, grass, brush, and any overhanging vegetation.

10. *Weirs*. These devices will be maintained clean of sediment and algae, kept upright, free flowing, and free of debris.

ANNUAL MAINTENANCE

The SWPB conducts annual inspections of the Martinsdale Dams and Reservoir. During these inspections, any items requiring annual maintenance will be identified and recorded. Items that may need annual maintenance include the dam embankments, spillway, outlet works, gates, riprap and gatehouse. Other routine items need needing immediate attention, such as the need to remove soil buildup infront of spillway chanel, trees, willows, or brush, will also be noted.

After the inspection, the SWPB sends the association a Dam Safety Inspection Report and a Maintenance Schedule Report. The reports identify items that need maintenance and provides a schedule of when the maintenance tasks need to be completed. The association is responsible for performing the maintenance items within the times specified.

The dam operator or association members may perform the maintenance tasks. However, major repairs are likely be handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the work.

RECORD KEEPING

The SWPB will maintain records, including photographs, of all inspections, and maintenance requirements. These records also include seepage monitoring observations. Anyone who wants to review these records may so in the SWPB's office at the Department of Natural Resources and Conservation in Helena, Montana.

The dam operator will keep records of the reservoir elevation, seepage observations or measurements, and any unusual conditions. These records may be reviewed at the dam operator's house.

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APPENDICES

APPENDIX A

RATING CURVES AND TABLES

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE
MARTINSDALE RESERVOIR

Pins installed 9/13/2000.
Elevations established with a level from Drill Hole No. 1 (top of pipe) on 9/14/2000.
The 0+00 pin is 103 feet west of the old location and 25 feet downslope from the southast corner of the FW&P vault toilet.
The pin alignment is 130 degrees magnetic and a path was cleared through the loose rocks.
Spillway crest elevation of 4779.25 feet is at 0+41.25 slope distance.
Storage volumes based on 1938 original hand surveys of the reservoir.

DISTANCE	ELEVATION	STORAGE
0+00 CAP	4784.54	29,139
1	4784.41	28,995
2	4784.29	28,863
3	4784.16	28,719
4	4784.03	28,576
5	4783.90	28,433
6	4783.77	28,289
7	4783.64	28,146
8	4783.51	28,003
9	4783.39	27,870
10	4783.26	27,727
11	4783.13	27,583
12	4783.00	27,440
13	4782.90	27,330
14	4782.80	27,219
15	4782.70	27,109
16	4782.60	26,998
17	4782.49	26,887
18	4782.39	26,767
19	4782.29	26,656
20	4782.19	26,546
21	4782.10	26,446
22	4782.00	26,336
23	4781.90	26,226
24	4781.80	26,115
25	4781.69	25,994
26	4781.59	25,884
27	4781.49	25,773
28	4781.34	25,608
29	4781.17	25,421
30	4781.01	25,244
31	4780.85	25,057
32	4780.52	24,668
33	4780.35	24,468
E. Spillway 33.6	4780.25	24,350
34	4780.19	24,279
35	4780.03	24,091
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
36	4780.00	24,056
37	4779.86	23,924
38	4779.70	23,773
39	4779.54	23,622
40	4779.40	23,490
41	4779.28	23,376
SPILLWAY 41.25	4779.25	23,348
42	4779.15	23,254
43	4779.02	23,131
44	4778.89	23,008
45	4778.76	22,885
46	4778.64	22,772
47	4778.51	22,649
48	4778.38	22,527
49	4778.25	22,404
50	4778.13	22,291
0+50 CAP	4778.12	22,281
51	4778.01	22,177
52	4777.89	22,064
53	4777.78	21,960
54	4777.66	21,847
55	4777.54	21,734
56	4777.43	21,630
57	4777.31	21,517
58	4777.19	21,403
59	4777.08	21,300
60	4776.96	21,186
61	4776.84	21,073
62	4776.73	20,969
63	4776.61	20,856
64	4776.49	20,743
65	4776.38	20,639
66	4776.27	20,535
67	4776.16	20,431
68	4776.05	20,327
69	4775.94	20,223
70	4775.83	20,120
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
71	4775.72	20,016
72	4775.61	19,912
73	4775.50	19,808
74	4775.39	19,704
75	4775.28	19,600
76	4775.17	19,496
77	4775.06	19,393
78	4774.95	19,295
79	4774.84	19,205
80	4774.73	19,114
81	4774.62	19,024
82	4774.50	18,925
83	4774.39	18,835
84	4774.28	18,745
85	4774.17	18,655
86	4774.05	18,556
87	4773.93	18,458
88	4773.82	18,367
89	4773.70	18,269
90	4773.59	18,178
91	4773.47	18,080
93	4773.24	17,891
92	4773.35	17,891
94	4773.12	17,793
95	4773.01	17,702
96	4772.89	17,604
97	4772.78	17,513
98	4772.66	17,415
99	4772.54	17,316
100	4772.43	17,226
1+00 CAP	4772.42	17,218
101	4772.33	17,144
102	4772.24	17,070
103	4772.15	16,996
104	4772.06	16,922
105	4771.97	16,848
106	4771.88	16,774
107	4771.79	16,701
108	4771.71	16,635
109	4771.62	16,561
110	4771.53	16,487
111	4771.44	16,413
112	4771.35	16,339
113	4771.26	16,265
114	4771.17	16,192
115	4771.09	16,126
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
116	4771.00	16,052
117	4770.91	15,978
118	4770.82	15,904
119	4770.74	15,839
120	4770.65	15,765
121	4770.56	15,691
122	4770.48	15,625
123	4770.39	15,551
124	4770.31	15,486
125	4770.22	15,412
126	4770.13	15,338
127	4770.05	15,272
128	4769.96	15,202
129	4769.87	15,138
130	4769.79	15,080
131	4769.70	15,016
132	4769.61	14,951
133	4769.53	14,894
134	4769.44	14,829
135	4769.35	14,764
136	4769.26	14,700
137	4769.17	14,635
138	4769.09	14,578
139	4769.00	14,513
140	4768.91	14,448
141	4768.82	14,384
142	4768.73	14,319
143	4768.64	14,255
144	4768.55	14,190
145	4768.47	14,133
146	4768.38	14,068
147	4768.29	14,004
148	4768.20	13,939
149	4768.11	13,875
150	4768.02	13,810
1+50 CAP	4767.97	13,774
151	4767.92	13,739
152	4767.82	13,667
153	4767.72	13,595
154	4767.62	13,523
155	4767.51	13,444
156	4767.41	13,372
157	4767.31	13,301
158	4767.21	13,229
159	4767.11	13,157
160	4767.01	13,085
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
161	4766.90	13,006
162	4766.80	12,935
163	4766.70	12,863
164	4766.60	12,791
165	4766.50	12,720
166	4766.40	12,648
167	4766.31	12,583
168	4766.24	12,533
169	4766.16	12,476
170	4766.09	12,426
171	4766.02	12,375
172	4765.94	12,318
173	4765.87	12,268
174	4765.80	12,217
175	4765.72	12,160
176	4765.65	12,110
177	4765.57	12,052
178	4765.50	12,002
179	4765.43	11,952
180	4765.35	11,894
181	4765.28	11,844
182	4765.21	11,794
183	4765.13	11,736
184	4765.06	11,686
185	4764.97	11,624
186	4764.88	11,569
187	4764.80	11,520
188	4764.71	11,464
189	4764.62	11,409
190	4764.53	11,353
191	4764.45	11,304
192	4764.36	11,248
193	4764.27	11,193
194	4764.18	11,137
195	4764.09	11,082
196	4764.01	11,032
197	4763.92	10,977
198	4763.83	10,921
199	4763.74	10,866
2+00 CAP	4763.71	10,847
200	4763.66	10,816
201	4763.57	10,761
202	4763.49	10,711
203	4763.40	10,656
204	4763.32	10,606
205	4763.23	10,551
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
206	4763.15	10,502
207	4763.07	10,452
208	4762.98	10,397
209	4762.90	10,347
210	4762.81	10,292
211	4762.73	10,242
212	4762.64	10,187
213	4762.56	10,138
214	4762.47	10,082
215	4762.39	10,033
216	4762.30	9,977
217	4762.22	9,928
218	4762.14	9,878
219	4762.05	9,823
220	4761.97	9,773
221	4761.88	9,718
222	4761.80	9,669
223	4761.72	9,619
224	4761.64	9,570
225	4761.56	9,521
226	4761.48	9,471
227	4761.40	9,422
228	4761.32	9,372
229	4761.24	9,323
230	4761.16	9,274
231	4761.08	9,224
232	4761.00	9,175
233	4760.92	9,126
234	4760.84	9,076
235	4760.76	9,027
236	4760.68	8,978
237	4760.60	8,928
238	4760.52	8,879
239	4760.34	8,768
240	4760.15	8,651
241	4759.96	8,538
242	4759.77	8,444
243	4759.57	8,344
244	4759.38	8,250
245	4759.19	8,155
246	4759.00	8,061
247	4758.81	7,966
248	4758.62	7,872
249	4758.43	7,777
2+50 CAP	4758.34	7,732
250	4758.24	7,683
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
251	4758.10	7,613
252	4757.97	7,548
253	4757.83	7,479
254	4757.69	7,409
255	4757.56	7,344
256	4757.42	7,275
257	4757.29	7,210
258	4757.15	7,141
259	4757.01	7,071
260	4756.88	7,006
261	4756.74	6,937
262	4756.61	6,872
263	4756.47	6,802
264	4756.33	6,732
265	4756.20	6,668
266	4756.06	6,598
267	4755.92	6,528
268	4755.79	6,464
269	4755.68	6,409
270	4755.57	6,354
271	4755.46	6,300
272	4755.35	6,245
273	4755.24	6,190
274	4755.14	6,141
275	4755.03	6,086
276	4754.92	6,041
277	4754.81	6,001
278	4754.70	5,960
279	4754.59	5,920
280	4754.49	5,883
281	4754.38	5,842
282	4754.27	5,802
283	4754.16	5,761
284	4754.05	5,720
285	4753.94	5,680
286	4753.84	5,643
287	4753.73	5,602
288	4753.62	5,562
289	4753.51	5,521
290	4753.40	5,481
291	4753.29	5,440
292	4753.18	5,399
293	4753.08	5,363
294	4752.97	5,322
295	4752.86	5,281
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
296	4752.75	5,241
297	4752.64	5,200
298	4752.53	5,160
299	4752.42	5,119
300	4752.32	5,082
3+00 CAP	4752.26	5,060
301	4752.24	5,053
302	4752.16	5,023
303	4752.08	4,994
304	4752.00	4,964
305	4751.92	4,934
306	4751.84	4,905
307	4751.76	4,875
308	4751.68	4,846
309	4751.60	4,816
310	4751.53	4,791
311	4751.45	4,761
312	4751.37	4,732
313	4751.29	4,702
314	4751.21	4,672
315	4751.13	4,643
316	4751.05	4,613
317	4750.97	4,584
318	4750.89	4,554
319	4750.82	4,529
320	4750.74	4,499
321	4750.67	4,473
322	4750.60	4,447
323	4750.52	4,418
324	4750.45	4,392
325	4750.38	4,366
326	4750.31	4,340
327	4750.23	4,311
328	4750.16	4,285
329	4750.09	4,259
330	4750.01	4,230
331	4749.94	4,210
332	4749.87	4,190
333	4749.79	4,168
334	4749.72	4,149
335	4749.65	4,130
336	4749.57	4,108
337	4749.50	4,089
338	4749.43	4,070
339	4749.37	4,053
340	4749.30	4,034
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
341	4749.23	4,015
342	4749.16	3,996
343	4749.10	3,979
344	4749.03	3,960
345	4748.96	3,941
346	4748.89	3,922
347	4748.83	3,906
348	4748.76	3,886
349 NOT USED - MEASUREMENT ERROR		
350	4748.68	3,865
3+50 CAP	4748.64	3,854
351	4748.60	3,843
352	4748.53	3,824
353	4748.45	3,802
354	4748.37	3,780
355	4748.29	3,758
356	4748.21	3,736
357	4748.13	3,714
358	4748.06	3,695
359	4747.98	3,674
360	4747.90	3,652
361	4747.82	3,630
362	4747.74	3,608
363	4747.66	3,586
364	4747.59	3,567
365	4747.51	3,545
366	4747.43	3,523
2,784	4747.35	3,501
368	4747.27	3,479
369	4747.19	3,457
370	4747.11	3,435
371	4747.03	3,413
372	4746.94	3,389
373	4746.86	3,367
374	4746.78	3,345
375	4746.70	3,315
376	4746.62	3,301
377	4746.54	3,279
378	4746.45	3,255
379	4746.37	3,233
380	4746.29	3,211
381	4746.21	3,189
382	4746.13	3,167
383	4746.05	3,164
384	4745.97	3,124
385	4745.88	3,099
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
386	4745.80	3,077
387	4745.72	3,055
388	4745.64	3,033
389	4745.55	3,009
390	4745.47	2,987
391	4745.39	2,965
392	4745.30	2,940
393	4745.22	2,918
394	4745.14	2,896
395	4745.06	2,874
396	4744.97	2,852
397	4744.89	2,835
398	4744.81	2,819
399	4744.73	2,802
4+00 CAP	4744.73	2,802
400	4744.65	2,786
401	4744.59	2,774
402	4744.52	2,759
403	4744.46	2,747
404	4744.39	2,732
405	4744.33	2,720
406	4744.26	2,706
407	4744.20	2,693
408	4744.13	2,679
409	4744.07	2,666
410	4744.00	2,652
411	4743.93	2,638
412	4743.87	2,625
413	4743.80	2,611
414	4743.74	2,598
415	4743.67	2,584
416	4743.60	2,570
417	4743.54	2,557
418	4743.47	2,543
419	4743.41	2,530
420	4743.34	2,516
421	4743.26	2,500
422	4743.18	2,483
423	4743.10	2,467
424	4743.02	2,450
425	4742.95	2,436
426	4742.87	2,419
427	4742.79	2,403
428	4742.71	2,386
429	4742.63	2,370
430	4742.55	2,353
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
431	4742.47	2,337
432	4742.39	2,320
433	4742.32	2,306
434	4742.24	2,289
435	4742.16	2,273
436	4742.09	2,259
437	4742.01	2,242
438	4741.93	2,226
439	4741.86	2,211
440	4741.78	2,195
441	4741.72	2,182
442	4741.66	2,170
443	4741.61	2,160
444	4741.55	2,147
445	4741.49	2,135
446	4741.43	2,123
447	4741.37	2,110
448	4741.32	2,100
449	4741.26	2,088
4+50 CAP	4741.32	2,100
450	4741.20	2,075
451	4741.11	2,057
452	4741.02	2,038
453	4740.94	2,024
454	4740.85	2,003
455	4740.76	1,985
456	4740.67	1,966
457	4740.58	1,947
458	4740.50	1,931
459	4740.41	1,912
460	4740.32	1894
461	4740.28	1886
462	4740.23	1875
463	4740.19	1867
464	4740.14	1857
465	4740.10	1849
466	4740.06	1840
467	4740.01	1830
468	4739.97	1824
469	4739.92	1816
470	4739.88	1810
471	4739.81	1800
472	4739.74	1790
473	4739.68	1781
474	4739.61	1771
475	4739.54	1760
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
476	4739.47	1,750
477	4739.40	1,740
478	4739.34	1,731
479	4739.27	1,721
480	4739.20	1,710
481	4739.13	1,700
482	4739.06	1,690
483	4739.00	1,681
484	4738.93	1,671
485	4738.86	1,660
486	4738.79	1,650
487	4738.72	1,640
488	4738.66	1,631
489	4738.59	1,621
490	4738.52	1,610
491	4738.43	1,597
492	4738.34	1,584
493	4738.25	1,571
494	4738.16	1,558
495	4738.08	1,546
496	4737.99	1,533
497	4737.90	1,519
498	4737.81	1,506
499	4737.72	1,493
5+00 CAP	4737.69	1,488
500	4737.63	1,480
501	4737.57	1,471
502	4737.50	1,461
503	4737.44	1,452
504	4737.38	1,443
505	4737.32	1,434
506	4737.25	1,424
507	4737.19	1,415
508	4737.13	1,406
509	4737.06	1,396
510	4737.00	1,387
511	4736.94	1,378
512	4736.89	1,371
513	4736.83	1,362
514	4736.77	1,353
515	4736.72	1,346
516	4736.66	1,337
517	4736.60	1,328
518	4736.54	1,319
519	4736.49	1,312
520	4736.43	1,303
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
521	4736.36	1293
522	4736.29	1,283
523	4736.23	1,274
524	4736.16	1,264
525	4736.09	1,253
526	4736.02	1,243
527	4735.95	1,233
528	4735.89	1,224
529	4735.82	1,214
530	4735.75	1,203
531	4735.71	1197
532	4735.68	1,193
533	4735.64	1,187
534	4735.61	1,183
535	4735.57	1,177
536	4735.53	1,171
537	4735.50	1,167
538	4735.46	1,161
539	4735.43	1,156
540	4735.39	1,150
541	4735.33	1,142
542	4735.27	1,133
543	4735.20	1,122
544	4735.14	1,114
545	4735.08	1,105
546	4735.02	1,096
547	4734.96	1,089
548	4734.89	1,082
549	4734.83	1,076
5+50 CAP	4734.94	1,087
550	4734.77	1,070
551	4734.69	1,063
552	4734.61	1,055
553	4734.52	1,046
554	4734.44	1,038
555	4734.36	1,030
556	4734.28	1,022
557	4734.20	1,015
558	4734.11	1,006
559	4734.03	998
560	4733.95	990
561	4733.89	984
562	4733.83	978
563	4733.77	972
564	4733.71	966
565	4733.65	960
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
566	4733.58	953
567	4733.52	947
568	4733.46	942
569	4733.40	936
570	4733.34	930
571	4733.26	922
572	4733.17	913
573	4733.09	905
574	4733.00	896
575	4732.92	888
576	4732.83	879
577	4732.75	872
578	4732.66	863
579	4732.58	855
580	4732.49	846
581	4732.41	838
582	4732.34	831
583	4732.26	823
584	4732.19	817
585	4732.11	809
586	4732.03	801
587	4731.96	793
588	4731.88	785
589	4731.81	778
590	4731.73	771
591	4731.68	766
592	4731.63	761
593	4731.59	757
594	4731.54	752
595	4731.49	747
596	4731.44	742
597	4731.39	737
598	4731.35	733
599	4731.30	728
6+00 CAP	4731.41	739
600	4731.25	724
601	4731.20	719
602	4731.15	714
603	4731.10	709
604	4731.05	704
605	4731.00	699
606	4730.94	693
607	4730.89	688
608	4730.84	683
609	4730.79	678
610	4730.74	674
DISTANCE	ELEVATION	STORAGE

TABLE 1. SLOPE-ELEVATION-STORAGE TABLE (continued)
MARTINSDALE RESERVOIR

DISTANCE	ELEVATION	STORAGE
611	4730.68	668
612	4730.61	661
613	4730.55	655
614	4730.48	648
615	4730.42	642
616	4730.35	635
617	4730.29	629
618	4730.22	623
619	4730.16	617
620	4730.09	610
621	4730.03	604
622	4729.97	599
623	4729.90	595
624	4729.84	591
625	4729.78	587
626	4729.72	584
627	4729.66	580
628	4729.59	576
629	4729.53	572
630	4729.47	568
631	4729.39	563
632	4729.32	559
633	4729.24	554
634	4729.16	549
635	4729.09	545
636	4729.01	540
637	4728.93	535
638	4728.85	530
639	4728.78	525
640	4728.70	520
641	4728.62	515
642	4728.54	510
643	4728.46	506
644	4728.38	501
645	4728.30	496
646	4728.22	491
647	4728.14	486
648	4728.06	481
649	4727.98	476
6+50 CAP	4727.92	472
650	4727.90	471
651	4727.83	466
652	4727.76	462
653	4727.68	457
654	4727.61	453
655	4727.54	448
DISTANCE	ELEVATION	STORAGE

DISTANCE	ELEVATION	STORAGE
656	4727.47	444
657	4727.40	440
658	4727.32	435
659	4727.25	431
660	4727.18	426
661	4727.10	421
662	4727.02	416
663	4726.94	411
664	4726.86	406
665	4726.79	402
666	4726.71	397
667	4726.63	392
668	4726.55	387
669	4726.47	382
670	4726.39	377
671	4726.32	373
672	4726.25	369
673	4726.17	364
674	4726.10	359
675	4726.03	355
676	4725.96	351
677	4725.89	346
678	4725.81	341
679	4725.74	337
680	4725.67	333
681	4725.59	328
682	4725.50	322
683	4725.42	317
684	4725.33	311
6+85 CAP	4725.41	316
685	4725.25	307
686	4725.17	302
687	4725.08	296
688	4725.00	291
689	4724.91	288
690	4724.83	285
691	4724.77	282
692	4724.72	281
693	4724.66	278
694	4724.60	276
695	4724.55	274
696	4724.49	272
697	4724.43	270
698	4724.37	268
699	4724.32	266
700	4724.26	264
DISTANCE	ELEVATION	STORAGE

TABLE 2. TOTAL STORAGE IN ACRE-FEET

MARTINSDALE RESERVOIR

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
4715	3	5	7	9	11	14	16	18	20	22
4716	24	26	28	30	32	34	36	38	40	42
4717	44	46	48	50	52	55	57	59	61	63
4718	65	67	69	71	73	75	77	79	81	83
4719	85	87	89	91	93	95	98	100	102	104
4720	106	110	113	117	121	125	128	132	136	139
4721	143	147	150	154	158	162	165	169	173	176
4722	180	184	187	191	195	199	202	206	210	213
4723	217	221	224	228	232	236	239	243	247	250
4724	254	258	261	265	269	273	276	280	284	287
4725	291	297	303	310	316	322	328	334	341	347
4726	353	359	365	372	378	384	390	396	403	409
4727	415	421	427	434	440	446	452	458	465	471
4728	477	483	489	496	502	508	514	520	527	533
4729	539	545	551	558	564	570	576	582	589	595
4730	601	611	621	630	640	650	660	670	679	689
4731	699	709	719	728	738	748	758	768	777	787
4732	798	808	918	827	837	847	857	867	876	886
4733	896	906	916	926	936	946	955	965	975	985
4734	995	1,005	1,015	1,024	1,034	1,044	1,054	1,064	1,073	1,083
4735	1,093	1,108	1,122	1,137	1,152	1,167	1,181	1,196	1,211	1,225
4736	1,240	1,255	1,269	1,284	1,299	1,314	1,328	1,343	1,358	1,372
4737	1,387	1,402	1,416	1,431	1,446	1,461	1,475	1,490	1,505	1,519
4738	1,534	1,549	1,563	1,578	1,593	1,608	1,622	1,637	1,652	1,666
4739	1,681	1,696	1,710	1,725	1,740	1,755	1,769	1,784	1,799	1,813
4740	1,828	1,849	1,869	1,890	1,910	1,931	1,952	1,972	1,993	2,013
4741	2,034	2,055	2,075	2,096	2,116	2,137	2,158	2,178	2,199	2,219
4742	2,240	2,261	2,281	2,302	2,322	2,343	2,364	2,384	2,405	2,425
4743	2,446	2,467	2,487	2,508	2,528	2,549	2,570	2,590	2,611	2,631
4744	2,652	2,673	2,693	2,714	2,734	2,755	2,776	2,796	2,817	2,837
4745	2,858	2,885	2,913	2,940	2,968	2,995	3,022	3,050	3,077	3,105
4746	3,132	3,159	3,187	3,214	3,241	3,269	3,296	3,323	3,350	3,378
4747	3,405	3,432	3,460	3,487	3,515	3,542	3,569	3,597	3,624	3,652
4748	3,679	3,706	3,734	3,761	3,788	3,816	3,843	3,870	3,897	3,925
4749	3,952	3,979	4,007	4,034	4,062	4,089	4,116	4,144	4,171	4,199
4750	4,226	4,263	4,300	4,337	4,374	4,410	4,447	4,484	4,521	4,558

TABLE 2. TOTAL STORAGE IN ACRE-FEET (continued)

MARTINSDALE RESERVOIR

Elevation	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
4751	4,595	4,632	4,669	4,706	4,743	4,779	4,816	4,853	4,890	4,927
4752	4,964	5,001	5,038	5,075	5,112	5,148	5,185	5,222	5,259	5,296
4753	5,333	5,370	5,407	5,444	5,481	5,517	5,554	5,591	5,628	5,665
4754	5,702	5,739	5,776	5,813	5,850	5,886	5,923	5,960	5,997	6,034
4755	6,071	6,121	6,170	6,220	6,270	6,320	6,369	6,369	6,469	6,518
4756	6,568	6,618	6,668	6,717	6,767	6,817	6,867	6,917	6,966	7,016
4757	7,066	7,116	7,165	7,215	7,265	7,315	7,364	7,414	7,464	7,513
4758	7,563	7,613	7,663	7,712	7,762	7,812	7,862	7,912	7,961	8,011
4759	8,061	8,111	8,160	8,210	8,260	8,309	8,359	8,409	8,459	8,508
4760	8,558	8,620	8,681	8,743	8,805	8,867	8,928	8,990	9,052	9,113
4761	9,175	9,237	9,298	9,360	9,422	9,484	9,545	9,607	9,669	9,730
4762	9,792	9,854	9,915	9,977	10,039	10,101	10,162	11,224	10,286	10,347
4763	10,409	10,471	10,532	10,594	10,656	10,718	10,779	10,841	10,903	10,964
4764	11,026	11,088	11,149	11,211	11,273	11,335	11,396	11,458	11,520	11,581
4765	11,643	11,715	11,787	11,858	11,930	12,002	12,074	12,146	12,217	12,289
4766	12,361	12,433	12,504	12,576	12,648	12,720	12,791	12,863	12,935	13,006
4767	13,078	13,150	13,222	13,293	13,365	13,437	13,509	13,581	13,652	13,724
4768	13,796	13,868	13,939	14,011	14,083	14,155	14,226	14,298	14,370	14,441
4769	14,513	14,585	14,657	14,728	14,800	17,872	14,944	15,016	15,087	15,159
4770	15,231	15,313	15,395	15,477	15,559	15,641	15,724	15,806	15,888	15,970
4771	16,052	16,134	16,216	16,298	16,380	16,462	16,545	16,627	16,709	16,791
4772	16,873	16,955	17,037	17,119	17,201	17,283	17,366	17,448	17,530	17,612
4773	17,694	17,776	17,858	17,940	18,022	18,104	18,187	18,269	18,351	18,433
4774	18,515	18,597	18,679	18,761	18,843	18,925	19,008	19,090	19,172	19,254
4775	19,336	19,430	19,525	19,619	19,714	19,808	19,902	19,997	20,091	20,186
4776	20,280	20,374	20,469	20,583	20,658	20,752	20,846	20,941	21,035	21,130
4777	21,224	21,318	21,413	21,507	21,602	21,696	21,790	21,885	21,979	22,074
4778	22,168	22,262	22,357	22,451	22,546	22,640	22,734	22,829	22,923	23,018
4779	23,112	23,206	23,301	23,395	23,490	23,584	23,678	23,773	23,867	23,962
4780	24,056	24,174	24,291	24,409	24,527	24,645	24,762	24,880	24,998	25,115
4781	25,233		**4,784**	28,543		**4,787**	32,214		**4,790**	36,066
4782	26,336		**4,785**	29,646		**4,788**	33,498		**4,791**	37,512
4783	27,440		**4,786**	30,930		**4,789**	34,782		**4,792**	38,958

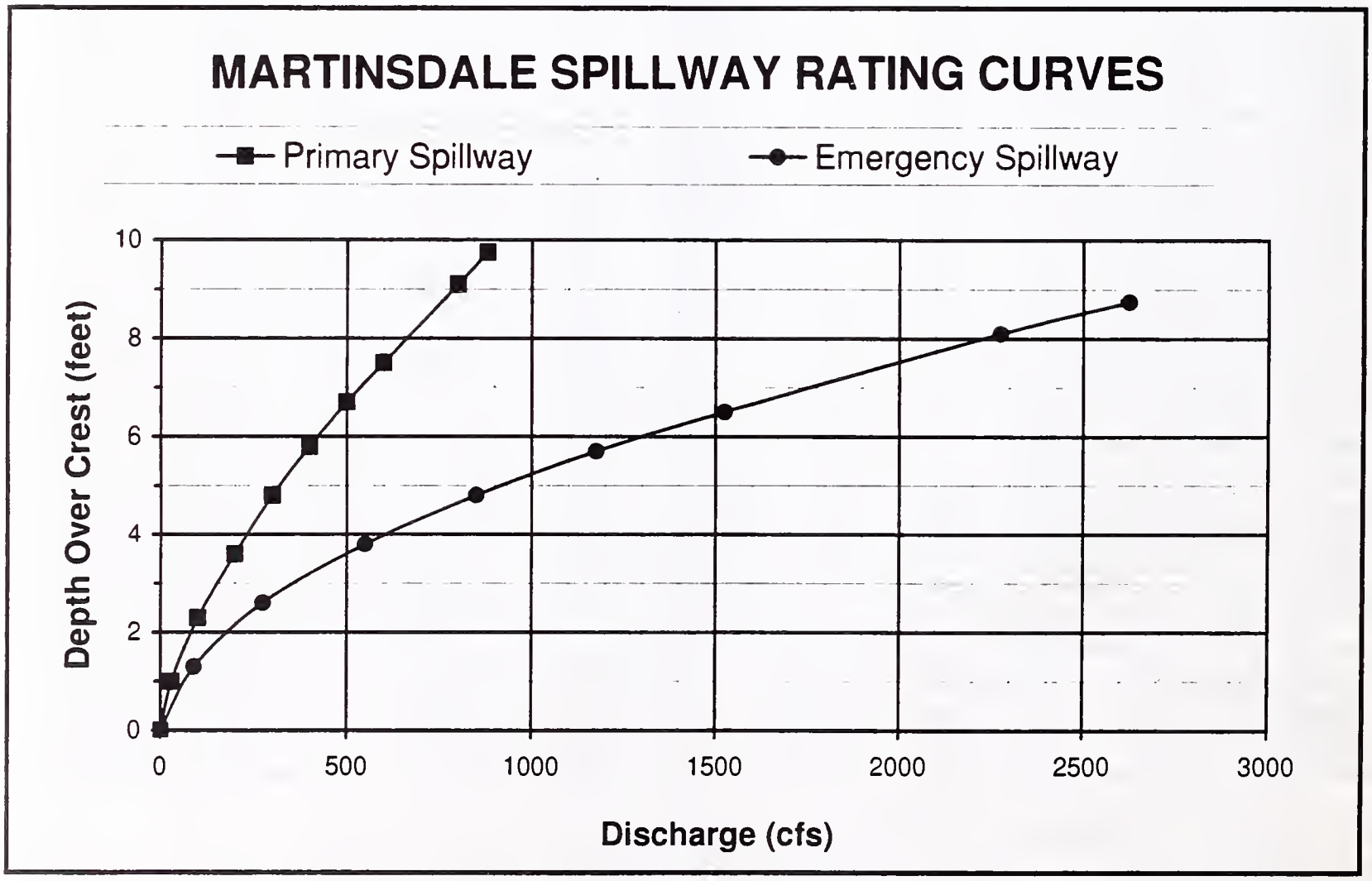
NOTE: Storage table based on 1938 original hand surveys of the reservoir.

Primary Spillway Crest	Elevation 4,779.25 feet	Storage 23,348 acre-feet
Emergency Spillway Crest	Elevation 4,780.25 feet	Storage 24,350 acre-feet
Dam Crest	Elevation 4,792.00 feet	Storage 38,958 acre-feet

TABLE 3. SPILLWAY DISCHARGE

MARTINSDALE RESERVOIR

Elevation (feet)	Primary Spillway		Emergency Spillway	
	Depth (feet)	Discharge (cfs)	Depth (feet)	Discharge (cfs)
4,779.25	0	0		
4,780.25	1	29	0	0
4,781.55	2.3	100	1.3	90
4,782.85	3.6	200	2.6	275
4,784.05	4.8	300	3.8	550
4,785.05	5.8	400	4.8	850
4,785.95	6.7	500	5.7	1,175
4,786.75	7.5	600	6.5	1,525
4,788.35	9.1	800	8.1	2,275
4,789.00	9.75	880	8.75	2,625



Note: Data from the Corps of Engineers Phase 1 Inspection Report (1980).

APPENDIX B.

INSPECTION REPORT FORM

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM
DATE INSPECTED

INVENTORY NO. _____ OWNER _____
HAZARD CATEGORY _____ OPERATOR _____
TYPE OF DAM _____ STREAM _____
YEAR BUILT _____ DRAINAGE AREA _____

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	_____	_____
At spillway crest	_____	_____
At min. dam crest elevation	_____	_____

ITEM	YES	NO	REMARKS
1. EMBANKMENT			
A. Crest -- Height= Length= Width=			
(1) Any visual settlements?			
(2) Any misalignments?			
(3) Any cracking?			
(4) Any traffic damage?			
(5) Other?			

ITEM	YES	NO	REMARKS

1. EMBANKMENT (continued)

B. Upstream Face -- Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Is riprap protection adequate?			
(5) Any stone deterioration?			
(6) Any visual settlement, slumps, sloughing, depressions or bulges?			
(7) Adequate grass cover?			
(8) Debris on the dam face?			
(9) Other?			

C. Downstream Face--Slope=

(1) Any erosion?			
(2) Any longitudinal cracks?			
(3) Any transverse cracks?			
(4) Any visual settlement, slumps, sloughing, depressions or bulges?			
(5) Is the toe drain dry?			
(6) Are the relief wells flowing?			
(7) Any boils at the toe?			
(8) Any seepage areas?			
(9) Any traffic or animal damage?			
(10) Any burrowing animals?			
(11) Adequate grass cover?			
(12) Other?			

D. Amount and Type of Vegetation on the Dam

.

ITEM	YES	NO	REMARKS

2. ABUTMENT CONTACTS

A) Any erosion?			
B) Any visual differential movement?			
C) Any cracks?			
D) Any seepage present?			
E) Other?			

3. OUTLET WORKS

A. Intake Structure -- Size=

(1) Any settlement?			
(2) Any tilting?			
(3) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(4) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(5) Metal appurtenances:			
a. Any corrosion present?			
b. Any breakage present?			
(6) Trash rack?			
a. Condition?			
b. Anchor system secure?			
(7) Other?			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

B. Conduit -- Type = Size =

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Is the conduit metal?			
a. Any corrosion present?			
b. Protective coatings adequate?			
(4) Is the conduit misaligned?			
(5) Any calcium deposits?			
(6) Other?			

C. Gates and Tower

(1) Gates:			
a. Size: Operating: Emergency: b. Type: Operating: Emergency:			
(2) Controls operational?			
(3) Controls lubricated?			
(4) Operational problems?			
(5) Leakage around gates?			
(6) Condition of gate seals?			
(7) Any cavitation damage? If so, describe?			
(8) Describe air vent-size and condition.			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

C. Gates and Tower (continued)

(9) Is there a jet pump?			
a. Is it operational?			
b. Leakage?			
(10) Is the tower dry? ____ wet?			
(11) Any seepage in the tower?			
(12) Condition of the tower?			
(13) Any safety problems?			
(14) Ladder in good condition?			
(15) Condition of the gatehouse?			
(16) Emergency plan completed for the dam?			
a. Posted in the gatehouse?			
(17) Other?			

D. Stilling Basin

(1) Do concrete surfaces show:			
a. Spalling?			
b. Cracking?			
c. Erosion?			
d. Exposed reinforcement?			
(2) Do joints show:			
a. Displacement or offset?			
b. Loss of joint material?			
c. Leakage?			
(3) Do energy dissipaters show:			
a. Signs of deterioration?			
b. Are they covered with debris?			
(4) Other?			

ITEM	YES	NO	REMARKS

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:			
a. Eroding or backcutting?			
b. Sloughing?			
c. Obstructed?			
(2) Is released water:			
a. Undercutting the outlet?			
b. Eroding the embankment?			
(3) Other?			

4. SPILLWAY

A. Description

(1) Location?			
(2) Type of Spillway?			
(3) Size of Spillway?			
(4) Spillway lining?			
(5) Is there a weir?			
(6) Is the spillway in good condition?			
(7) Any drains?			
a. Describe the condition of drains.			

B. Does spillway show:

(1) Any cracking concrete?			
(2) Any spalling concrete?			
(3) Any exposed reinforcement in the concrete?			
(4) Any erosion?			

ITEM	YES	NO	REMARKS

4. SPILLWAY (continued)

4. B. Does spillway show: (continued)

(5) Any slope sloughing?			
(6) Any obstructions?			
(7) Displacement or offset joints?			
(8) Loss of joint material?			
(9) Leakage at the joints?			
(10) Other?			

C. Do the energy dissipaters show:

(1) Signs of deterioration?			
(2) Any cracking?			
(3) Any spalling?			
(4) Any exposed reinforcement?			
(5) Are they covered with debris?			
(6) Other?			

D. Has release water:

(1) Eroded the embankment?			
(2) Undercut the outlet?			
(3) Eroded the downstream channel?			
(4) Other?			

E. Emergency Spillway

(1) Is there an emergency spillway?			(If YES, describe)

ITEM	YES	NO	REMARKS

5. RESERVOIR CONTROL

A) Recent upstream development?			
B) Recent downstream development?			
C) Slides in reservoir area?			
D) Change in reservoir operation?			
E) Large impoundment upstream?			
F) Any debris in the reservoir?			
G) Other?			

6. INSTRUMENTATION

A) List type(s) of instrumentation:			
B) In good condition?			
C) Read periodically?			
D) Is data available?			
E) Include all data gathered since last report.			

7. DOWNSTREAM CONDITION

A. Downstream Land Use.

This dam was inspected by:

Additional comments and recommendations.

B10 2001

APPENDIX C

DISTRIBUTION LIST

MARTINSDALE DAMS O&M DISTRIBUTION LIST

		Number Of Copies
1.	State Water Projects Bureau Glen McDonald Kevin Smith Art Taylor (2) Bob Arrington Bob Clark Dolores Eustice	7
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5.	Water Users Eugene Taber -- President Kenneth Yerger -- Vice President Susan Moore -- Secretary	3
6.	Dam Operator Dam Operator (Keith Hill) Gate House	2
7.	State Library -- Attn: Roberta Gebhardt	4
8.	Extra	2
TOTAL		22

APPENDIX D

MONITORING WELL LOGS

(Note: No well logs were prepared for drill holes 301 through 360.)

DRILL HOLE COMPLETION

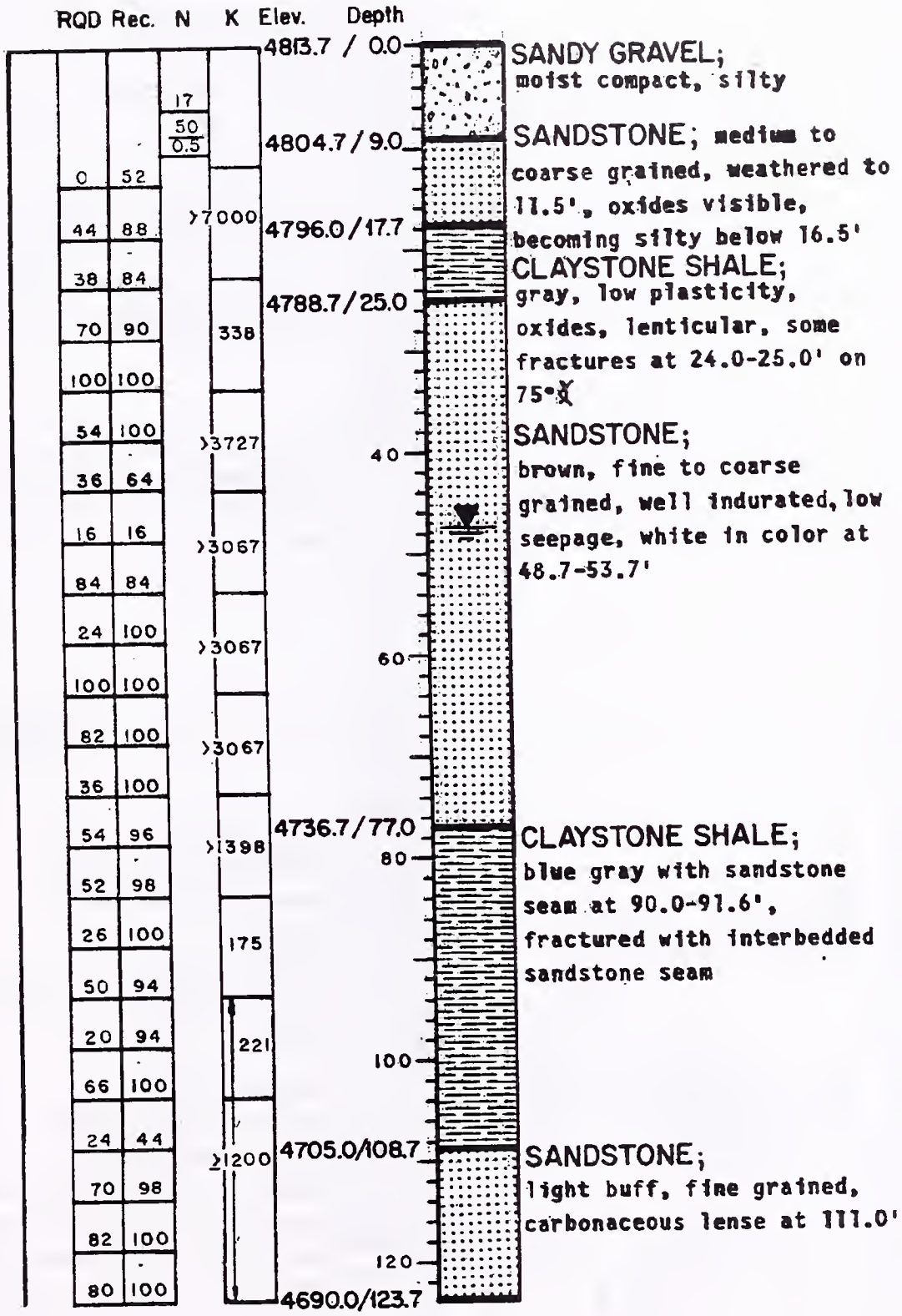
Drill Hole	Hole Depth (ft)	Screen/Piezometer	Sceen/Piez Depth (ft)	Screen/Piez Depth (9/4/01)
1	122.5	Slotted PVC screen	121.5	120.4
2E	160.0	Slotted PVC screen	110 to 142	131.1
2W	160.0	Slotted PVC screen	61	84.9
3E	122.5	Slotted PVC screen	32	Plugged
3W	122.5	Slotted PVC screen	106 to 117	115.9
4	116.8	Slotted PVC screen	111.8 to 116.8	119.6
4P	116.8	Casagrande Piezometer	80	70.8
5	101.3	Slotted PVC screen	98	96.1
6	123.3	Slotted PVC screen	120.3	118.8
7	122.3	Slotted PVC screen	121	121.3
8	80.0	Slotted PVC screen	52	50.0
8P	80.0	Casagrande Piezometer	60	60.0
9	91.5	Slotted PVC screen	91.5	90.9
9P	91.5	Casagrande Piezometer	45	41.0
10	55.5	Slotted PVC screen	23 to 43	44.5
11P	46.0	Casagrande Piezometer	40	49.6
12	30.0	Slotted PVC screen	29	30.2
13	70.0	Slotted PVC screen	32 to 50	47.0
14	20.6	Slotted PVC screen	20	19.9
15	93.4	Slotted PVC screen	93.4	64.7
16*	45.0	Slotted PVC screen	45	50.5
17	24.0	Slotted PVC screen	24	22.5
301		Slotted PVC screen		28.1
302		Slotted PVC screen		19.6
303		Slotted PVC screen		16.7
304		Slotted PVC screen		11.5
305		Slotted PVC screen		20.0
306		Slotted PVC screen		29.5

* slope inclinometer

Note: Data from Martinsdale Reservoir Seepage Monitoring Program and Stability Analysis Report, December 1982.

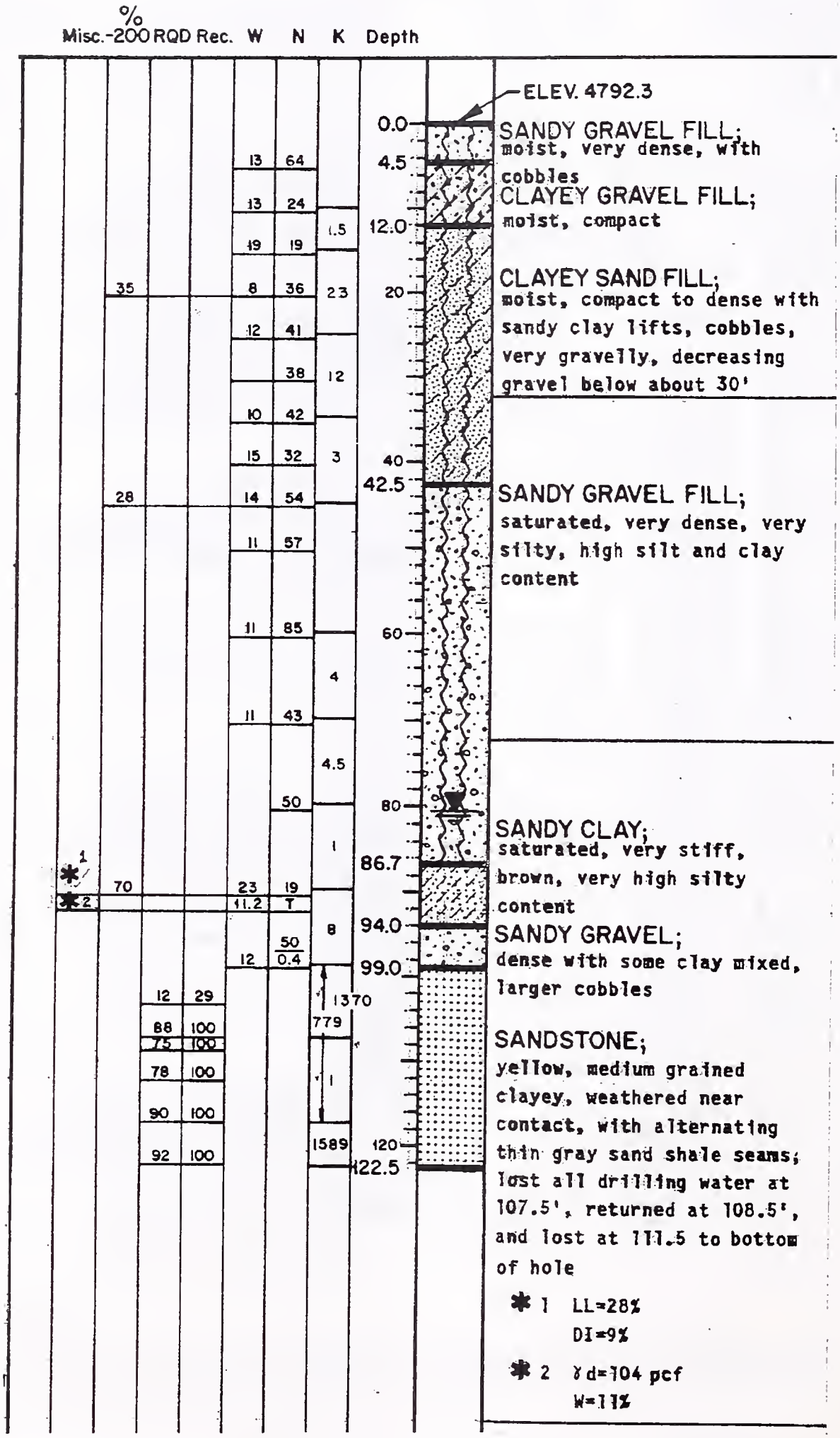
DRILL HOLE NO. 1 (DH-1)

NORTH DAM



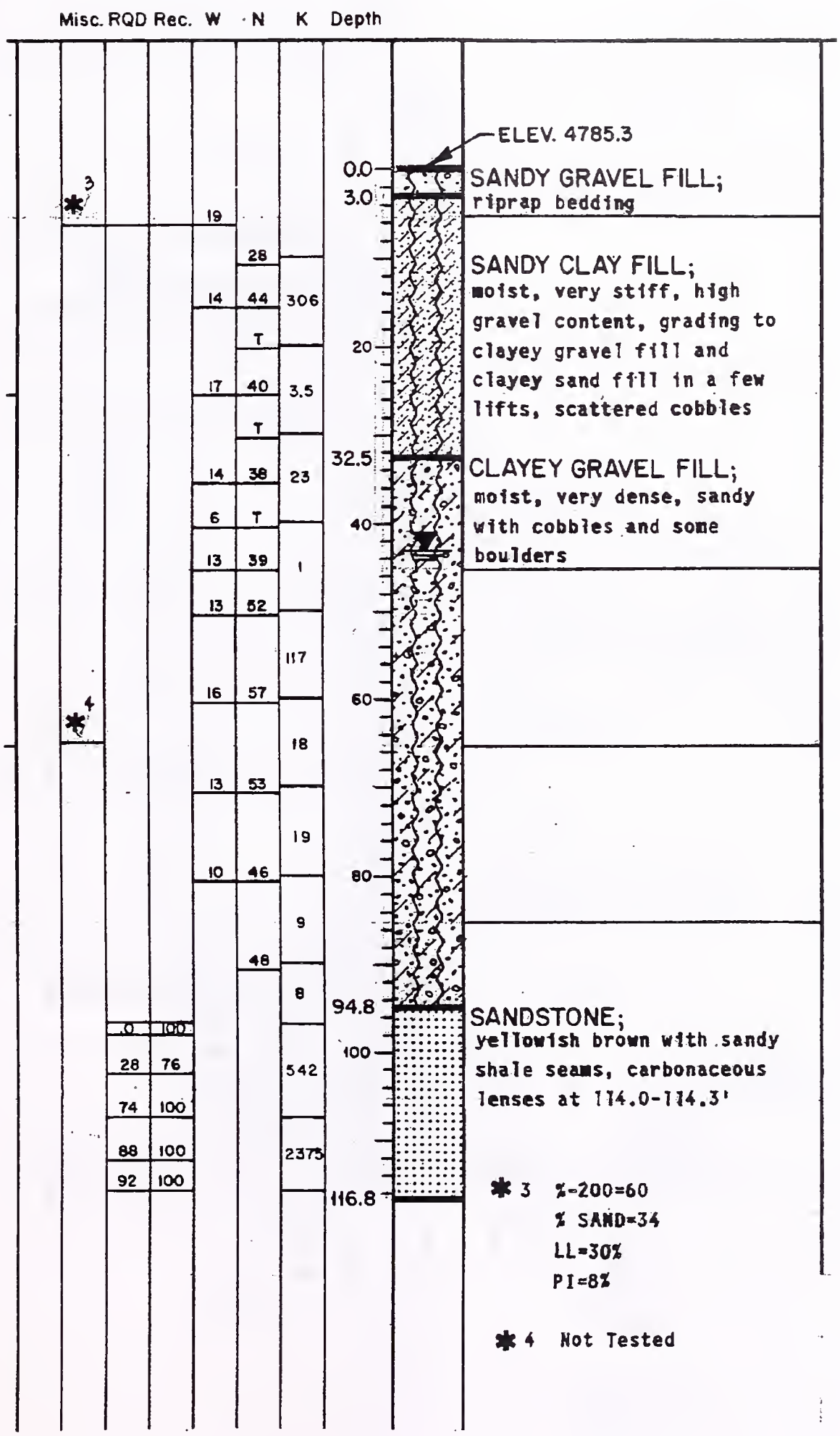
DRILL HOLE NO. 3 (DH-3)

NORTH DAM



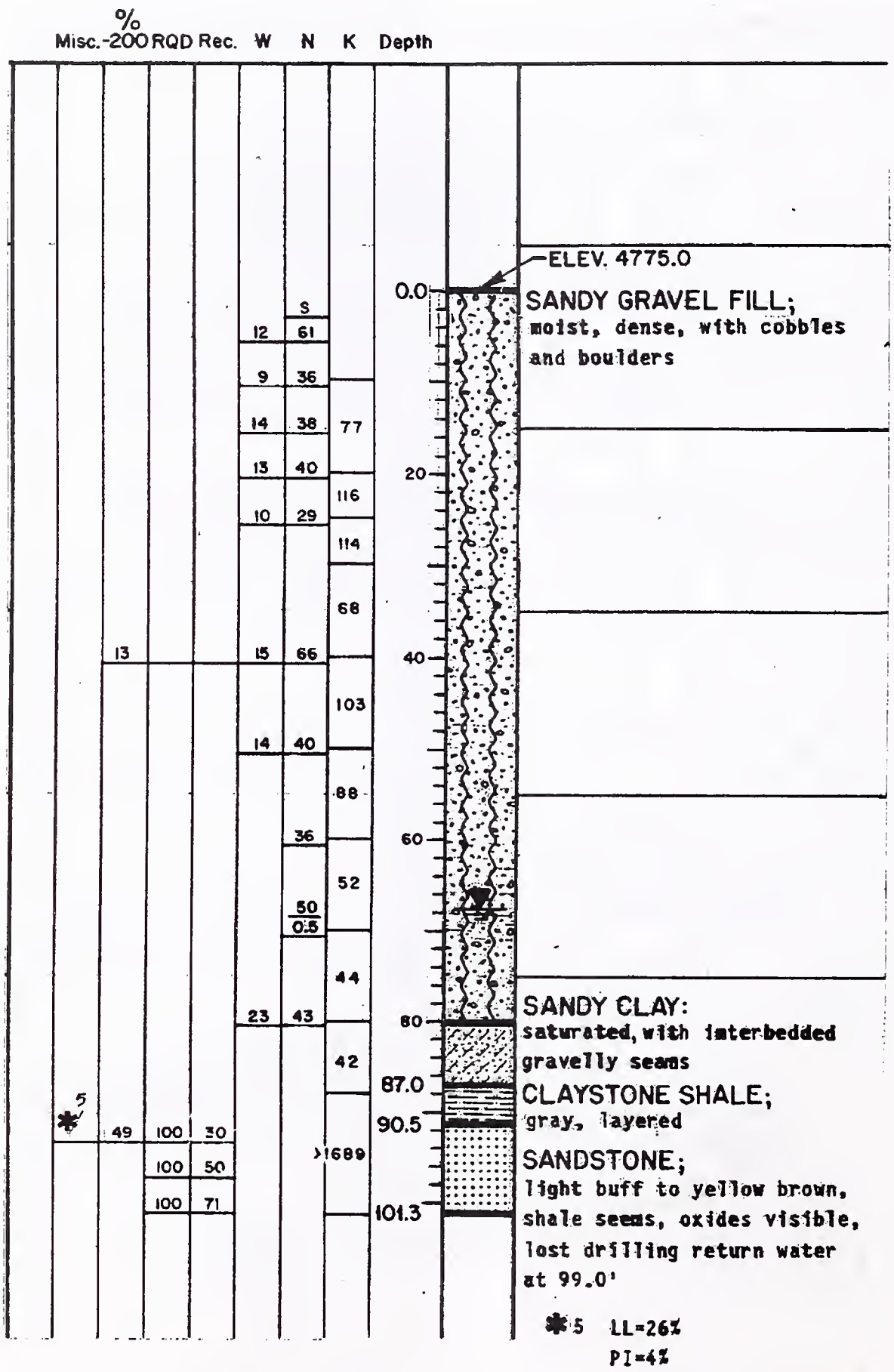
DRILL HOLE NO. 4 (DH-4)

NORTH DAM



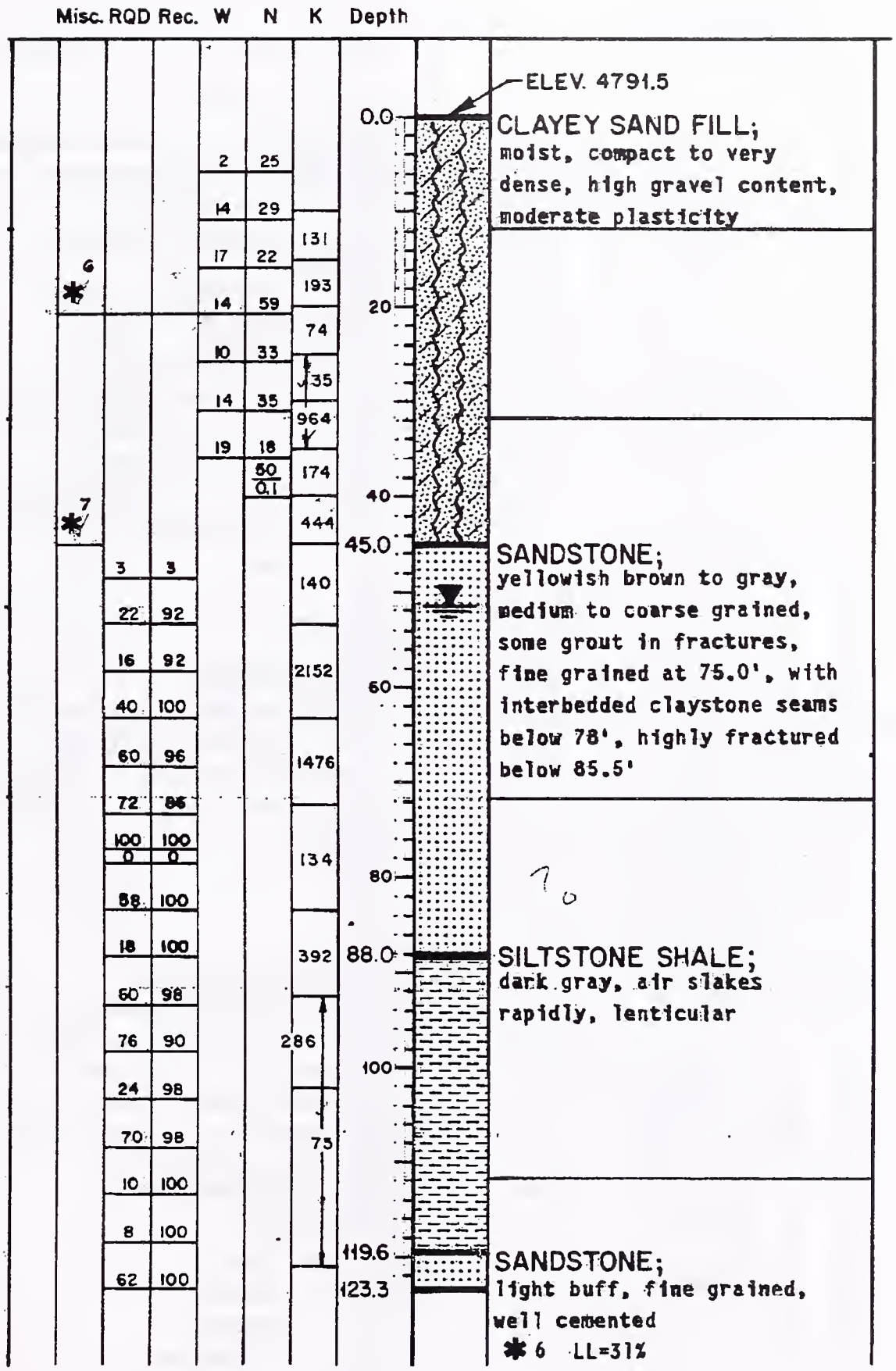
DRILL HOLE NO. 5 (DH-5)

NORTH DAM



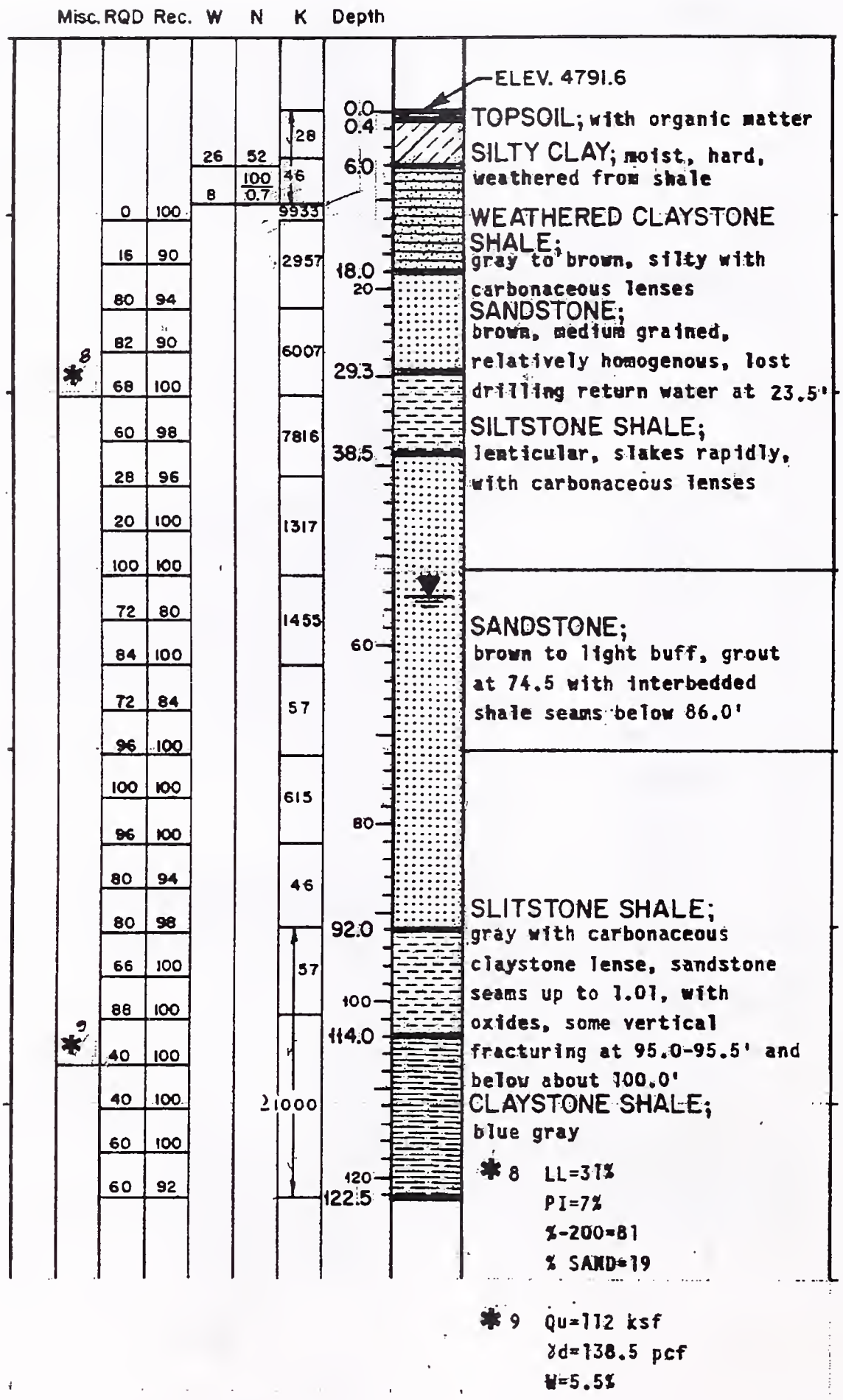
DRILL HOLE NO. 6 (DH-6)

NORTH DAM



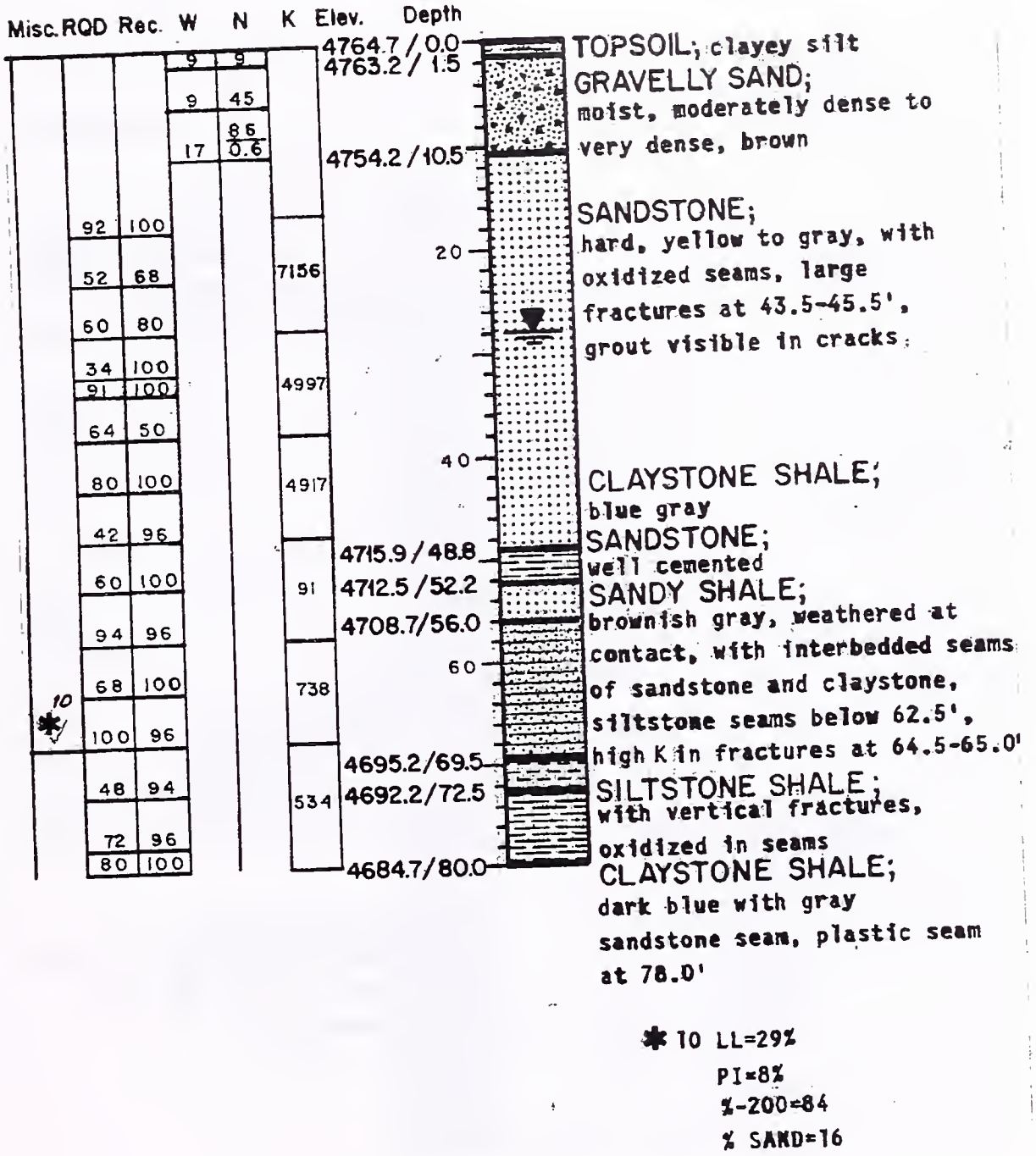
DRILL HOLE NO. 7 (DH-7)

NORTH DAM



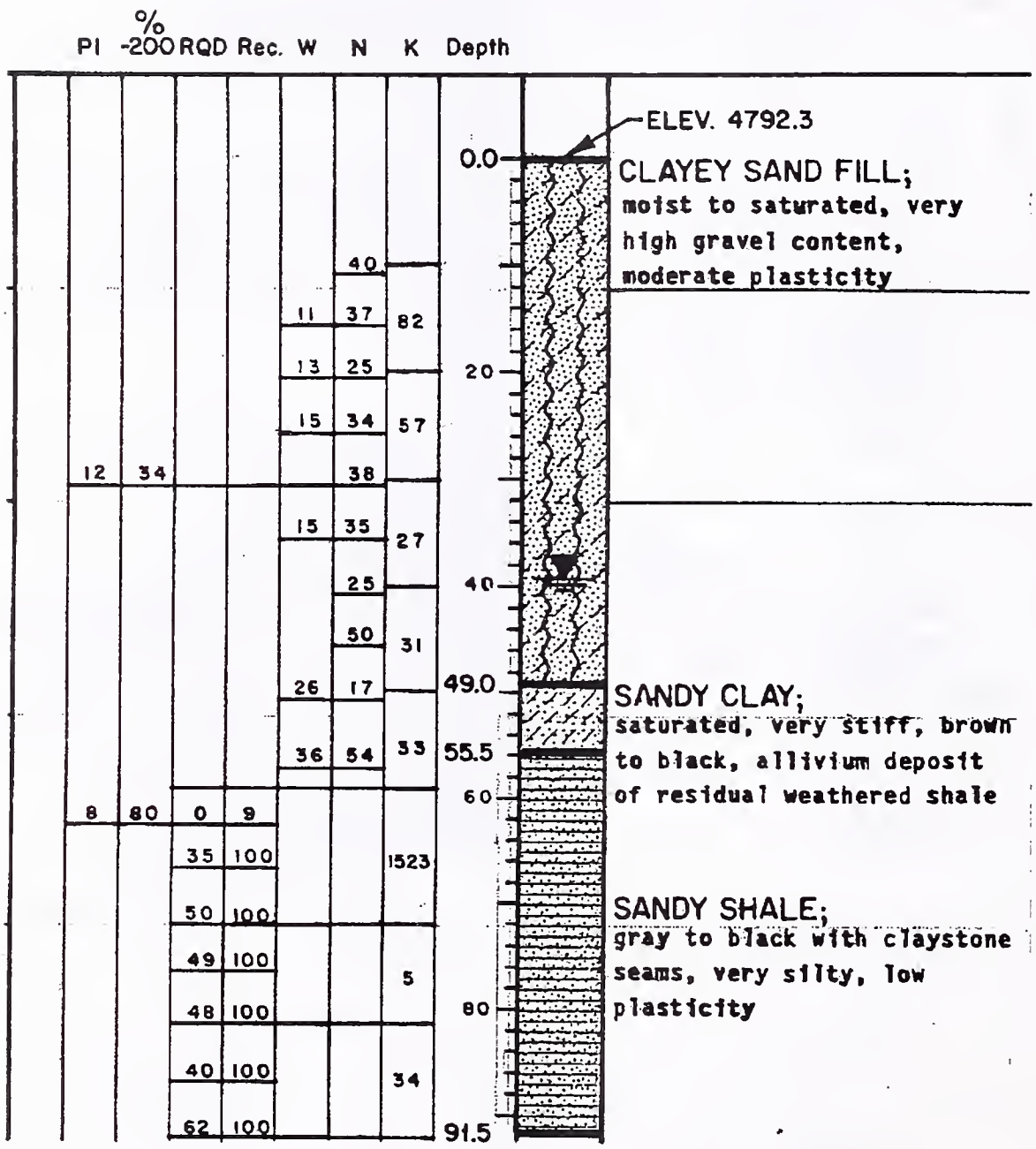
DRILL HOLE NO. 8 (DH-8)

NORTH DAM



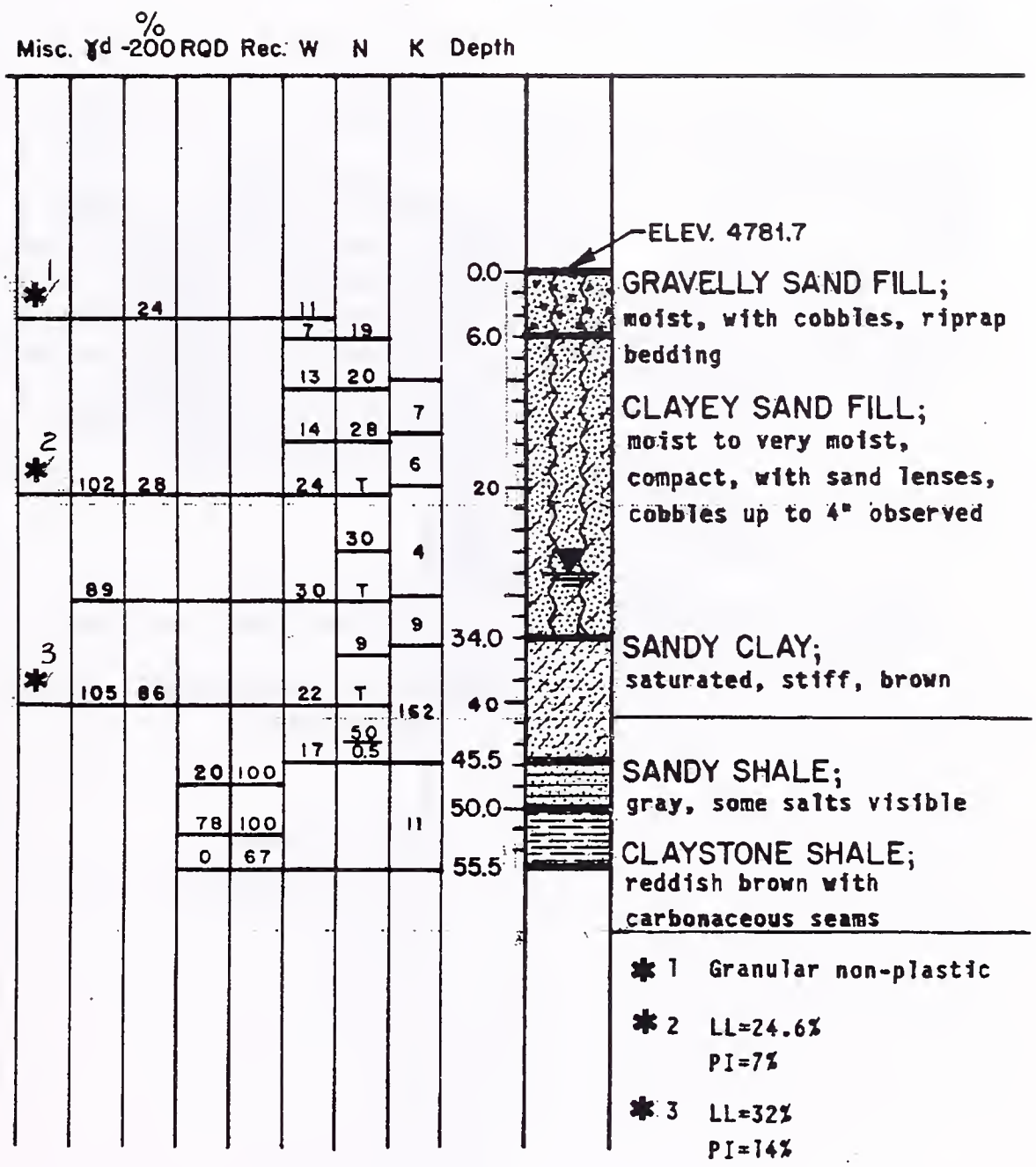
DRILL HOLE NO. 9 (DH-9)

EAST DAM



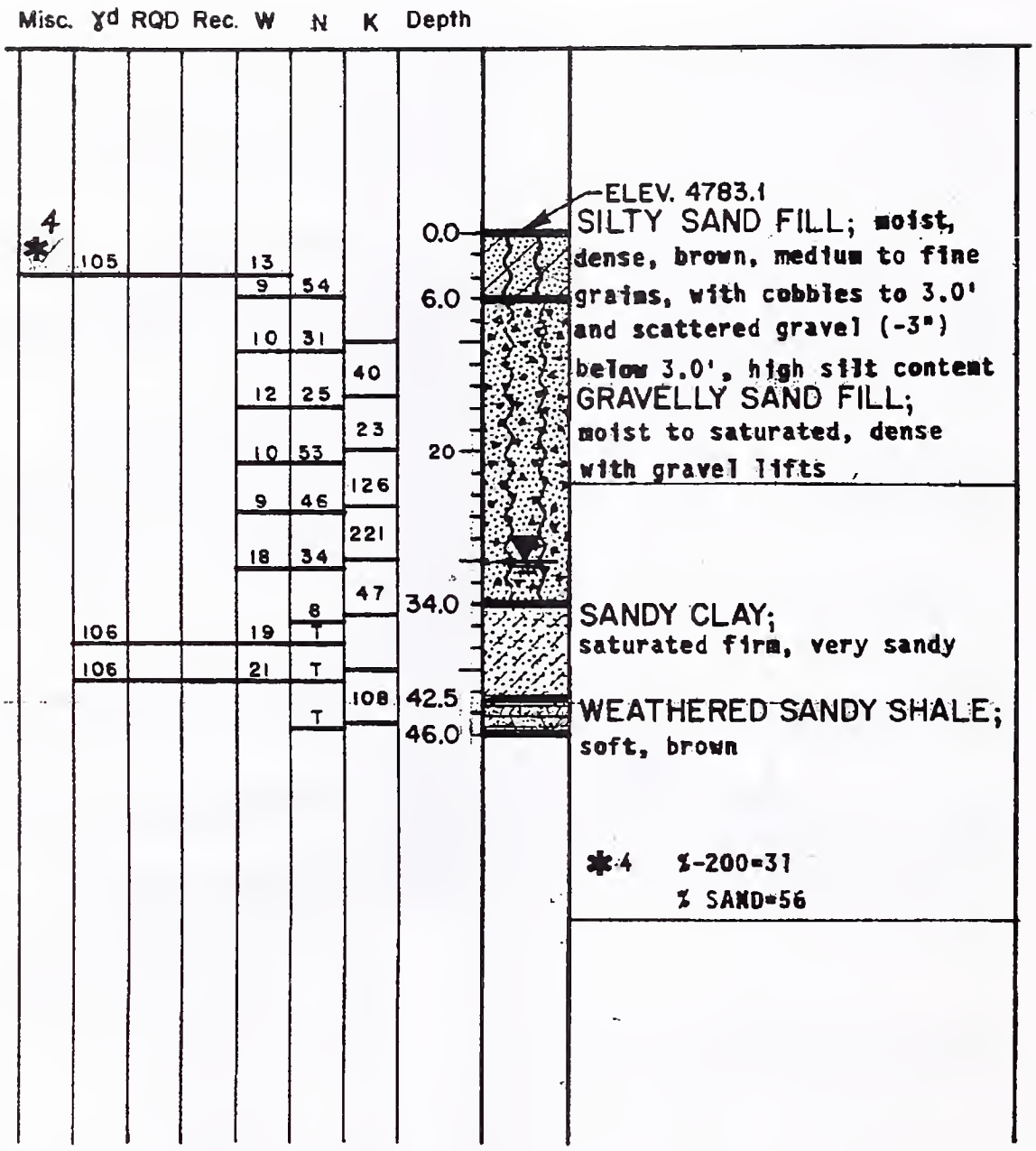
DRILL HOLE NO. 10 (DH-10)

EAST DAM



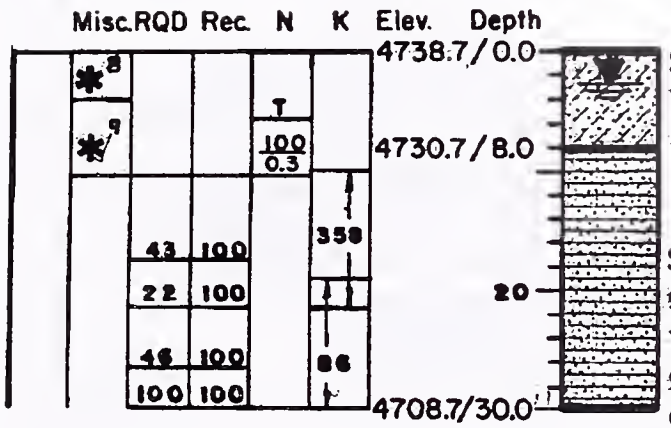
DRILL HOLE NO. 11 (DH-11)

EAST DAM



DRILL HOLE NO. 12 (DH-12)

EAST DAM



SANDY CLAY;
moist to saturated, firm, organic to 0.8' (weathered sandy shale)

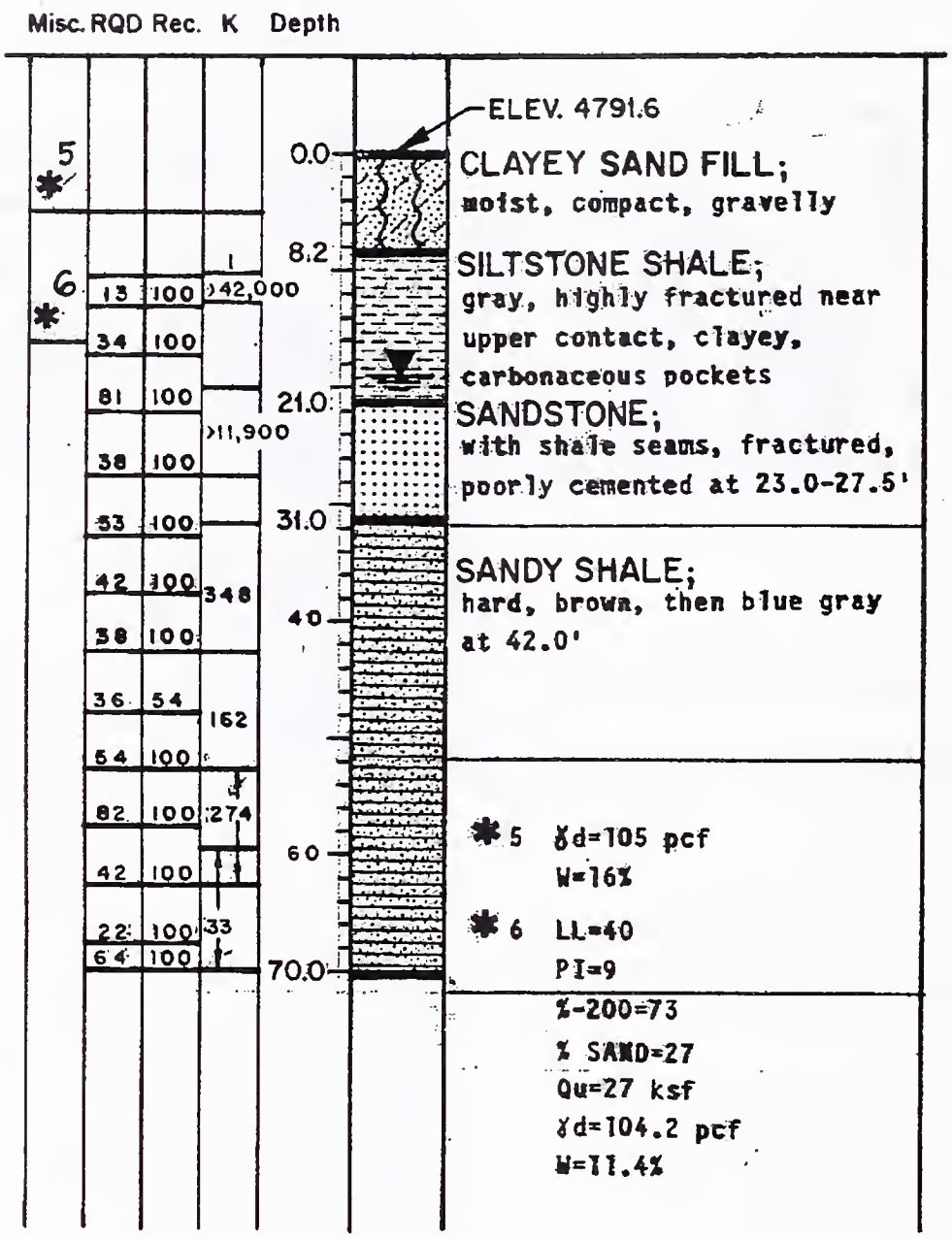
SANDY SHALE;
grayish brown, moderately fractured, color is blue gray below 27.0', with claystone seams

✱ 8 γd=100 pcf
W=18.6%

✱ 9 W=11%

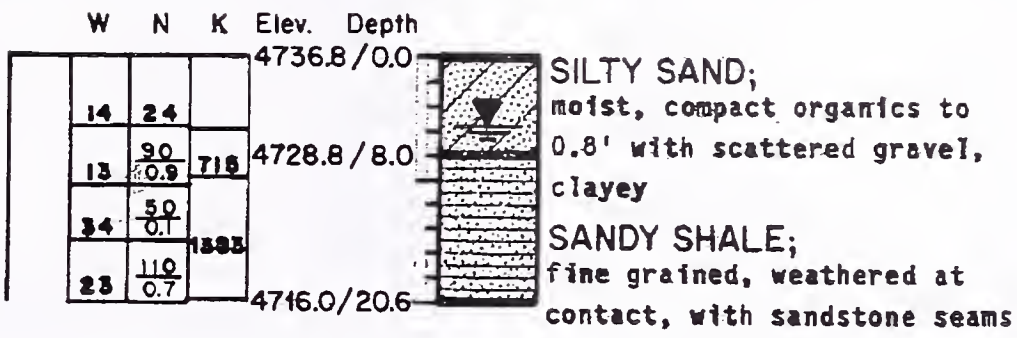
DRILL HOLE NO. 13 (DH-13)

EAST DAM



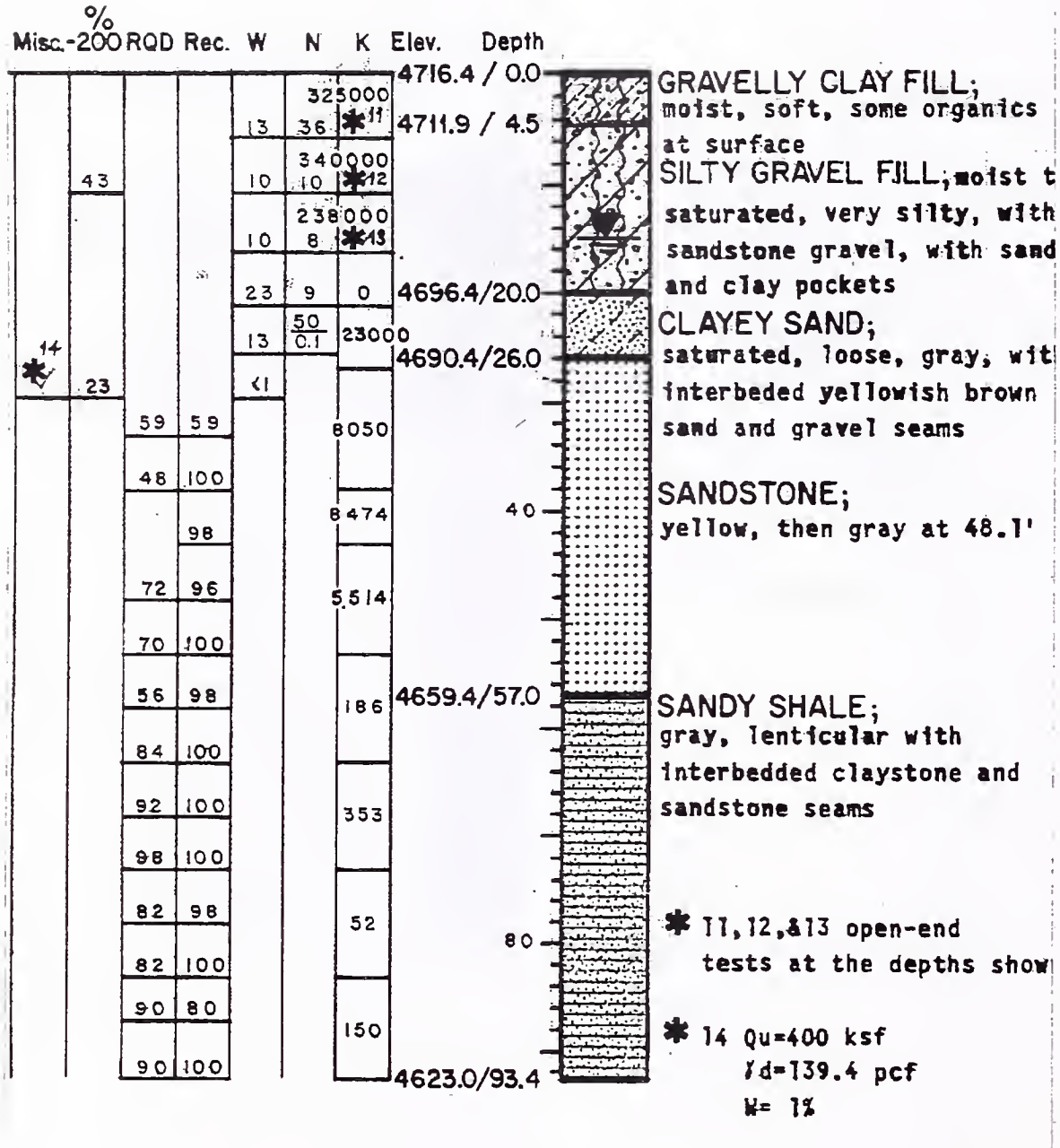
DRILL HOLE NO. 14 (DH-14)

EAST DAM



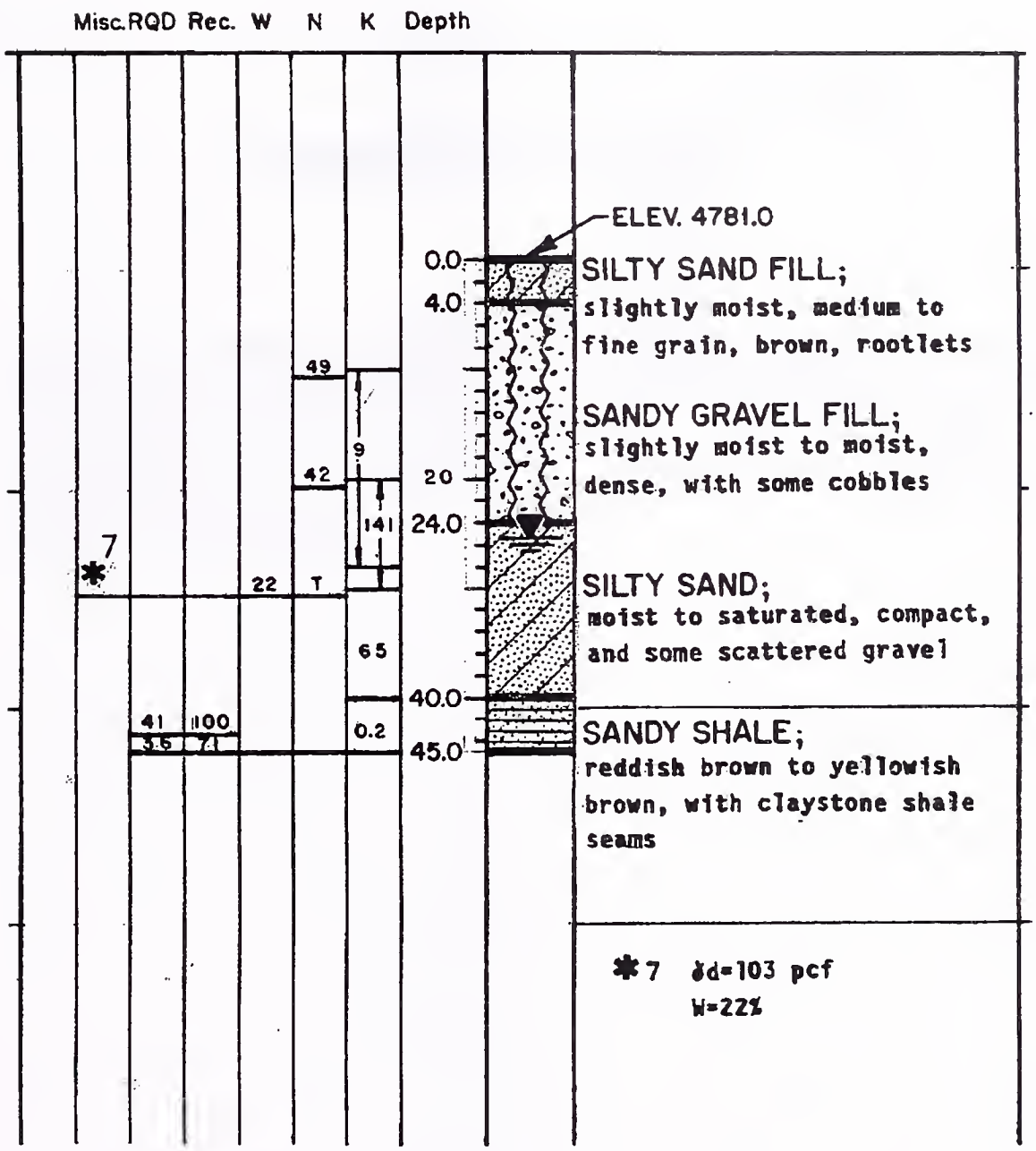
DRILL HOLE NO. 15 (DH-15)

NORTH DAM



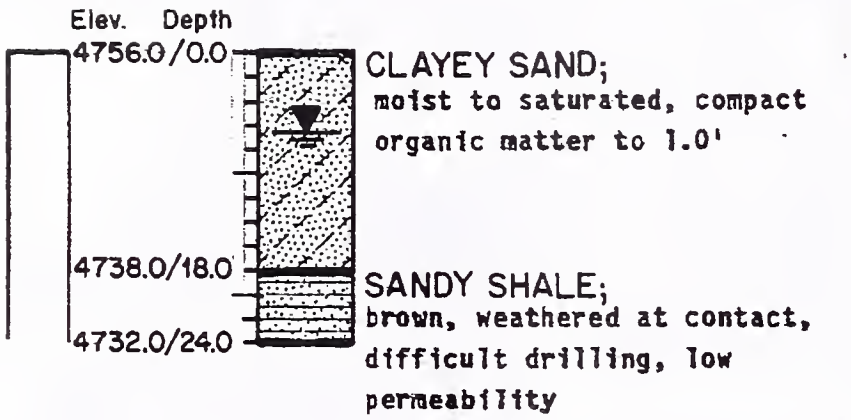
DRILL HOLE NO. 16 (DH-16)

EAST DAM



DRILL HOLE NO. 17 (DH-17)

EAST DAM

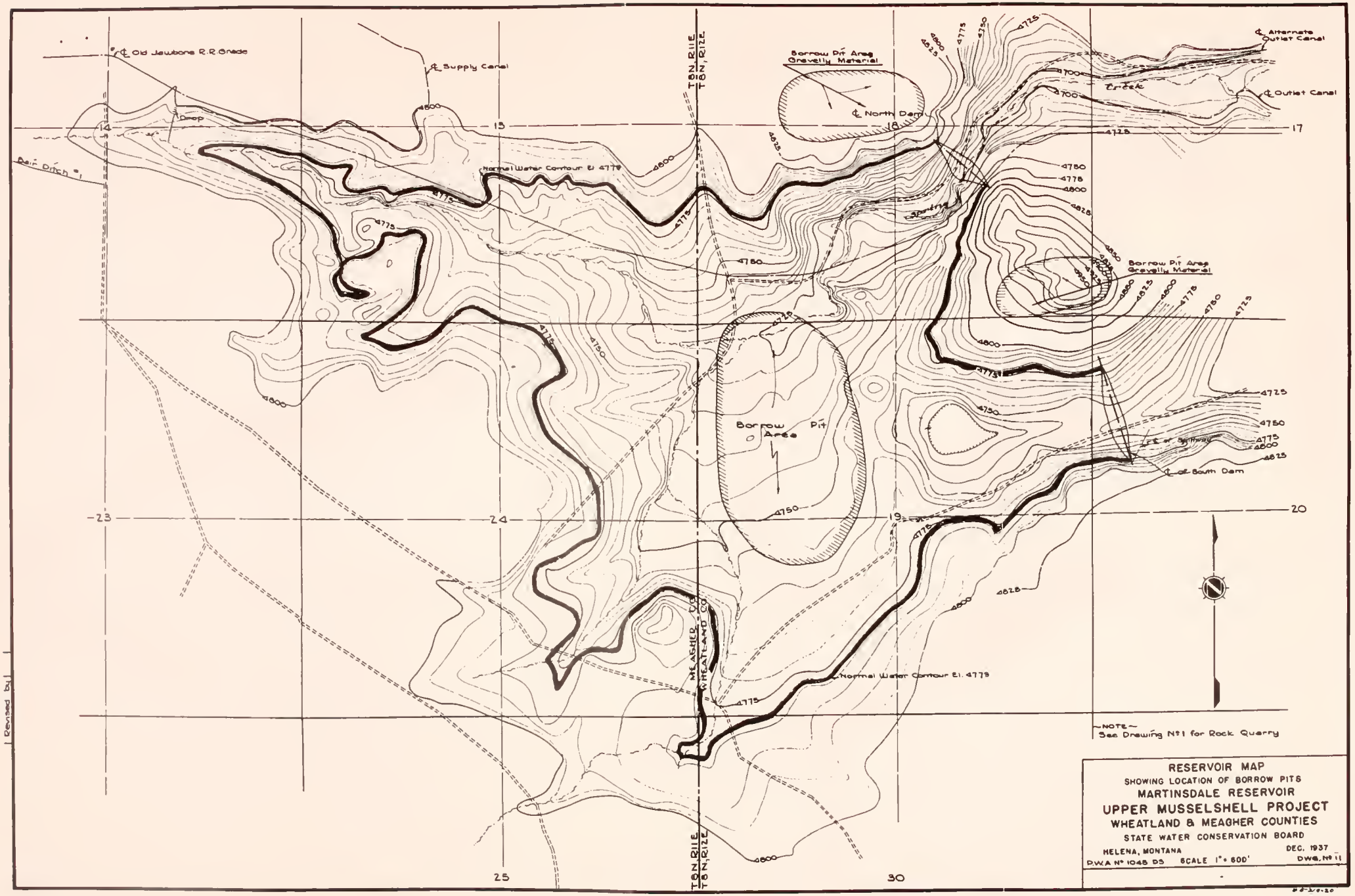


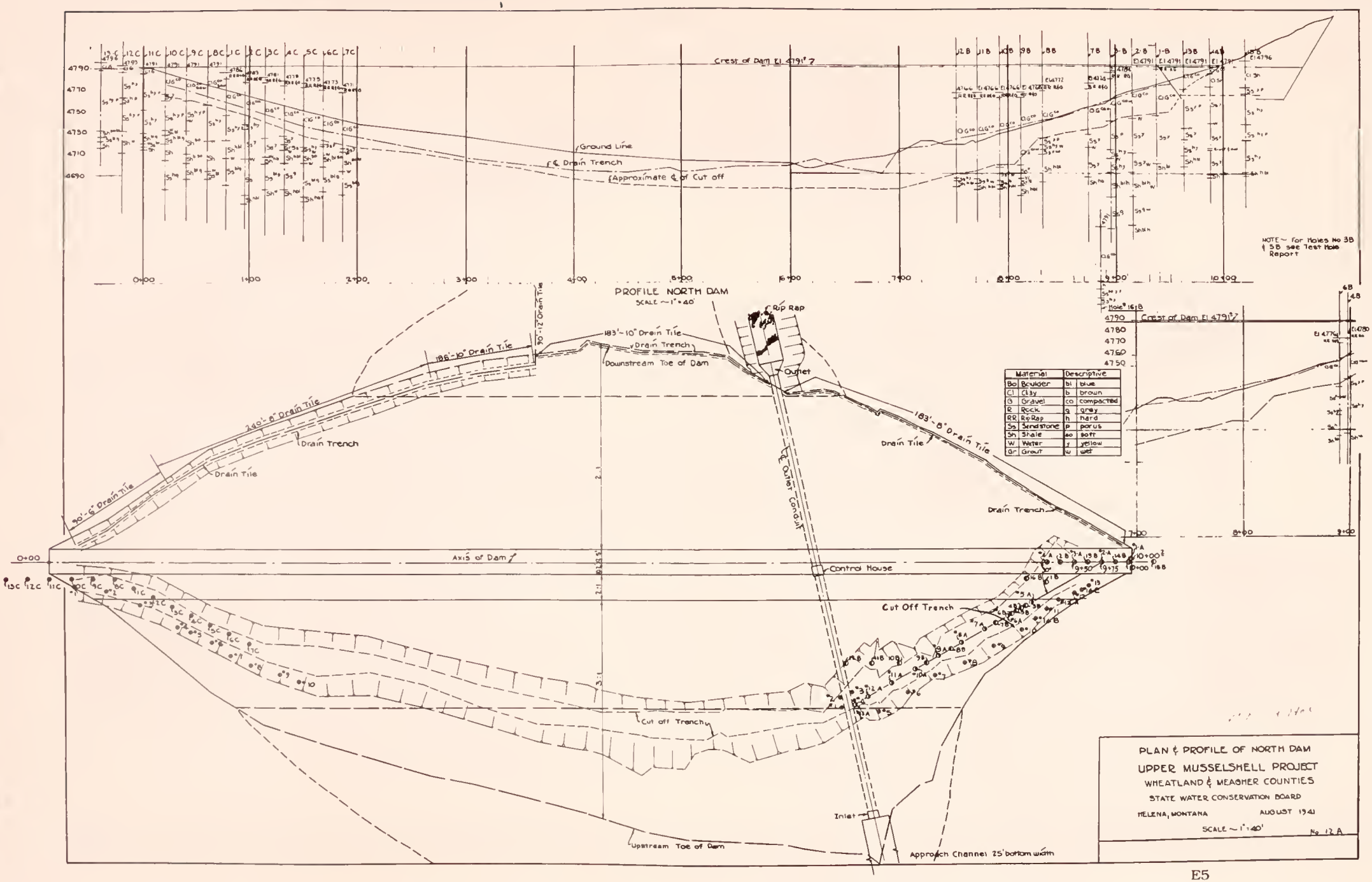
APPENDIX E

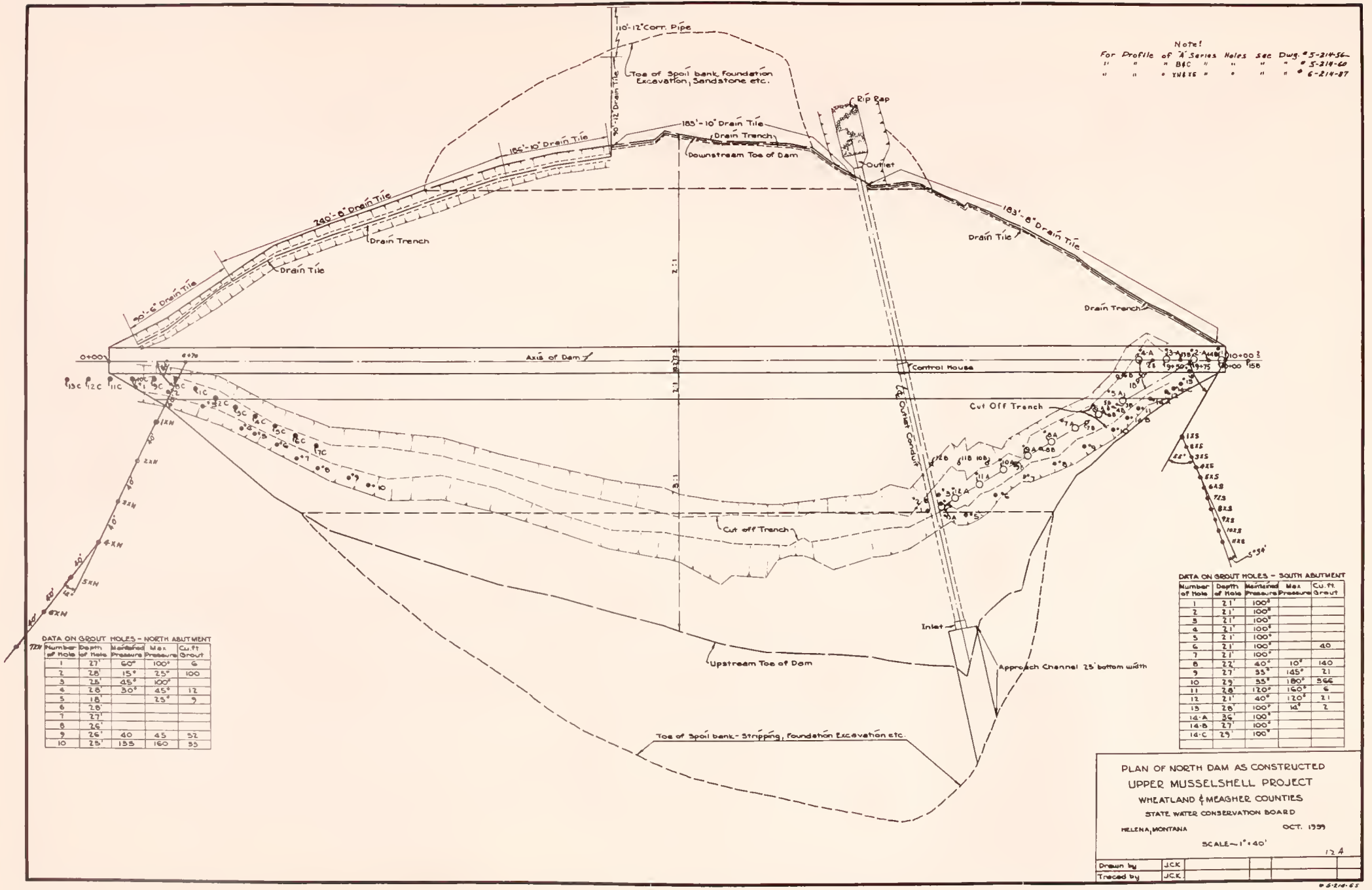
PROJECT DRAWINGS

(NOTE: Reduced project drawings E3 to E25 are design drawings and not "As Builts". These drawing should be used for reference only. The 1985, 1987 and 1988 drawings are "As-Builts". The SWPB has the full size project drawings.)

E2 2001


℄ Old Jawbone R.R. Grade
℄ Supply Canal
Drop
Lat. Ditch #1
Normal Water Contour El. 4778
Borrow Pit Area
Gravelly Material
℄ North Dam
℄ Alternate Outlet Canal
Creek
℄ Outlet Canal
Borrow Pit Area
Gravelly Material
Borrow Pit Area
℄ of Spillway
℄ of South Dam
T8N, R11E
T8N, R12E
13
14
15
16
17
18
19
20
23
24
25
30
MEAGHER CO.
WHEATLAND CO.
Normal Water Contour El. 4778
4600
4625
4650
4675
4700
4725
4750
4775
4800
4825
4850
Revised by
~NOTE~
See Drawing No 1 for Rock Quarry
RESERVOIR MAP
SHOWING LOCATION OF BORROW PITS
MARTINSDALE RESERVOIR
UPPER MUSSELSHELL PROJECT
WHEATLAND & MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA
DEC. 1937
D.W.A. No 1048 D5
SCALE 1" = 600'
DWG. No 11


Crest of Dam El. 4791'7
Ground Line
℄ Drain Trench
Approximate ℄ of Cut off
NOTE ~ for Holes No 3B & 5B see Test Hole Report
PROFILE NORTH DAM
SCALE ~ 1" = 40'
Rip Rap
Outlet
30-12" Drain Tile
183'-10" Drain Tile
Drain Trench
Downstream Toe of Dam
186'-10" Drain Tile
240'-8" Drain Tile
Drain Tile
183'-8" Drain Tile
Outlet Conduit
Axis of Dam
Control House
Cut Off Trench
Cut off Trench
Inlet
Upstream Toe of Dam
Approach Channel 25' bottom width
Material
Descriptive
Bo Boulder
bl blue
Cl Clay
b brown
G Gravel
co compacted
R Rock
g grey
RR Rip Rap
h hard
Ss Sandstone
p porus
Sh Shale
so soft
W Water
y yellow
Gr Grout
w wet
PLAN & PROFILE OF NORTH DAM
UPPER MUSSELSHELL PROJECT
WHEATLAND & MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA AUGUST 1941
SCALE ~ 1" = 40'
No. 12 A

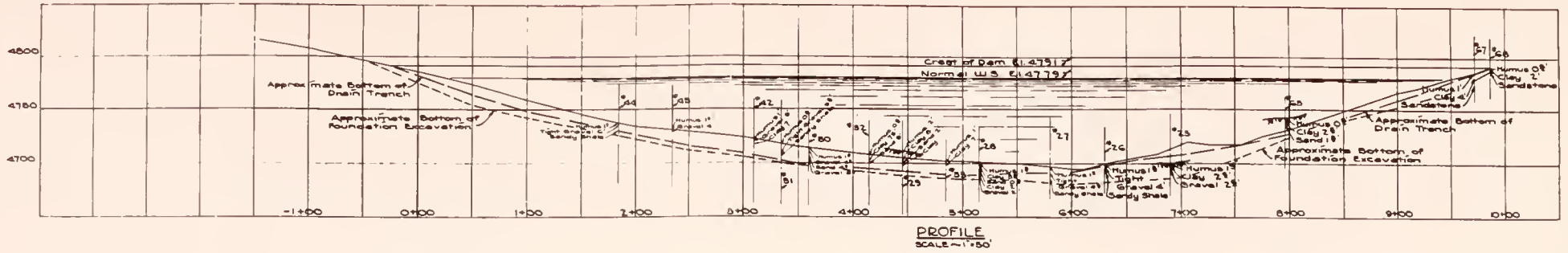


DATA ON GROUT HOLES - NORTH ABUTMENT

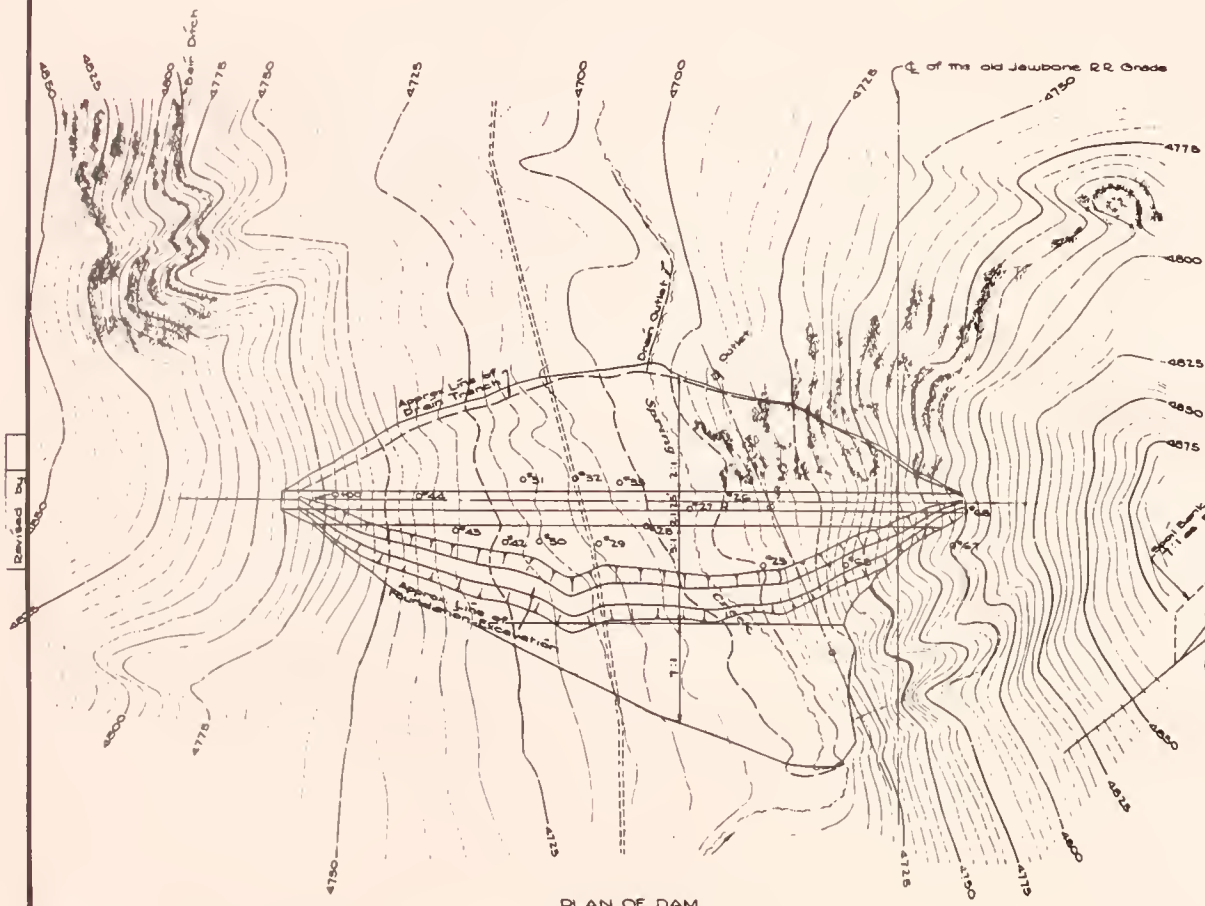
Number of Hole	Depth of Hole	Maintained Pressure	Max Pressure	Cu. ft Grout
1	27'	60#	100#	6
2	28'	15#	25#	100
3	25'	45#	100#	
4	28'	30#	45#	12
5	18'		25#	9
6	28'			
7	27'			
8	26'			
9	26'	40	45	52
10	25'	135	160	35

DATA ON GROUT HOLES - SOUTH ABUTMENT

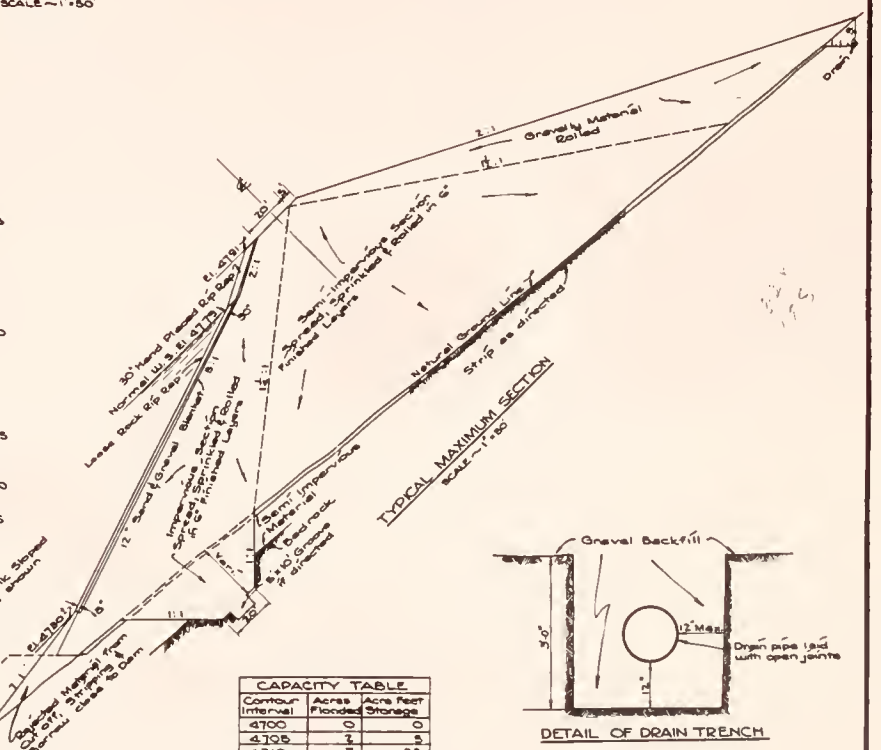
Number of Hole	Depth of Hole	Maintained Pressure	Max Pressure	Cu. ft Grout
1	21'	100#		
2	21'	100#		
3	21'	100#		
4	21'	100#		
5	21'	100#		
6	21'	100#		40
7	21'	100#		
8	22'	40#	10#	140
9	27'	35#	145#	21
10	29'	35#	180#	566
11	28'	120#	160#	6
12	21'	40#	120#	21
13	26'	100#	140#	2
14-A	36'	100#		
14-B	27'	100#		
14-C	29'	100#		



PROFILE
SCALE ~ 1" = 50'


℄ of the old Jawbone R.R. Grade
Approx. Line of Drain Trench
Approx. Line of Foundation Excavation
Drain Outlet
Spring
Rock Bank Sloped 1:1 as shown
Revised by

PLAN OF DAM
SCALE ~ 1" = 100'

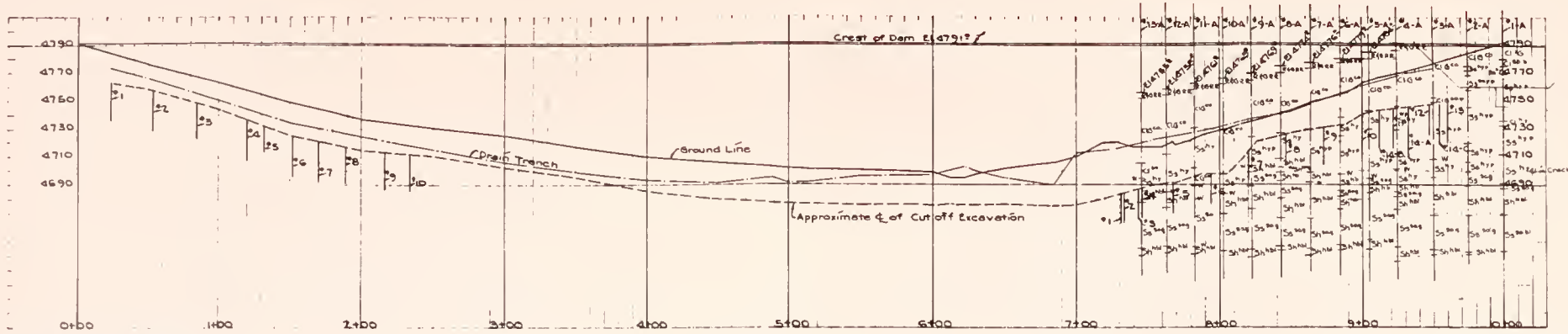

Gravelly Material Rolled
Semi-impervious Material Spread, Sprinkled & Rolled in 6" Layers
30' Hand Placed R.P. Rap
Normal W.S. El. 4779.7'
Loose Rock R.P. Rap
12' Sand & Gravel Blanket
Impervious Material Spread, Sprinkled & Rolled in 6" Layers
Natural Ground Line
Strip as directed
Semi-Impervious Material
Bed Rock
Grooved as directed
Existing Material from Drain Trench Stripping & Borrow, Used in Dam
TYPICAL MAXIMUM SECTION
SCALE ~ 1" = 50'

DETAIL OF DRAIN TRENCH

CAPACITY TABLE

Contour Interval	Acres Flooded	Acre Feet Storage
4700	0	0
4705	3	8
4710	7	28
4715	14	80
4720	27	183
4725	47	368
4730	77	678
4735	120	1170
4740	174	1906
4745	238	2933
4750	309	4305
4755	429	6148
4760	566	8635
4765	696	11720
4770	767	15308
4775	875	19415
4780	1015	24183
4785	1194	29650
4790	1574	36070
4795	1815	45300
4800	1650	51220

DETAILS OF NORTH DAM
MARTINSDALE RESERVOIR
UPPER MUSSELSHELL PROJECT
WHEATLAND & MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA — DEC. 1937
SCALE AS SHOWN
PWA No. 1048 D5 — DWG No. 12



PROFILE NORTH DAM
SCALE — 1" = 40'

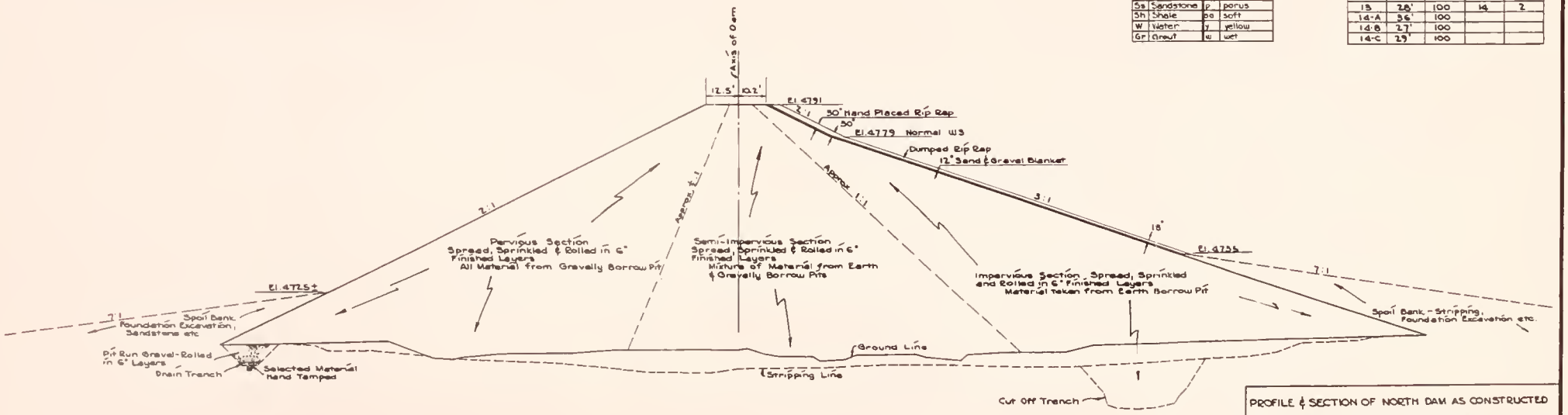
DATA ON GROUT HOLES - NORTH ABUTMENT

Number of Hole	Depth of Hole	Sustained Pressure	Max. Pressure	Cu.ft Grout
1	27'	60	100	6
2	28	15	25	100
3	25	45	100	
4	28	30	45	12
5	18		28	9
6	28			
7	27			
8	36			
9	26	40	45	32
10	25	138	160	33

Material		Descriptive	
Bo	Boulder	bl	blue
Cl	Clay	b	brown
g	Gravel	co	compacted
R	Rock	g	grey
RR	RipRap	h	hard
Ss	Sandstone	p	porus
Sh	Shale	so	soft
W	Water	y	yellow
Gr	Grout	w	wet

DATA ON GROUT HOLES - SOUTH ABUTMENT

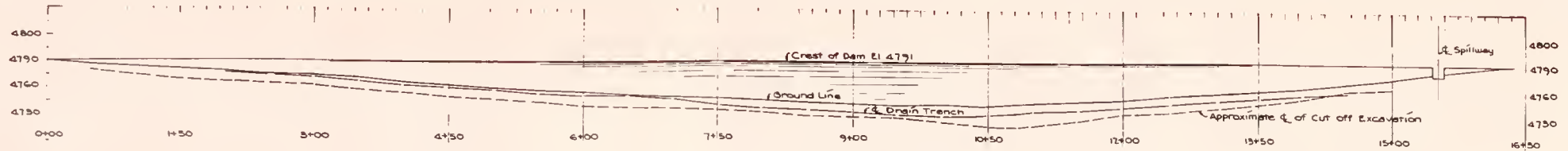
Number of Hole	Depth of Hole	Sustained Pressure	Max Pressure	Cu Ft Grout
1	21'	100		
2	21'	100		
3	21'	100		
4	21'	100		
5	21'	100		
6	21'	100		40
7	21'	100		
8	22'	40	10	140
9	27'	35	145	21
10	29'	55	180	366
11	28'	120	160	6
12	21'	40	120	21
13	28'	100	14	2
14-A	36'	100		
14-B	27'	100		
14-C	29'	100		



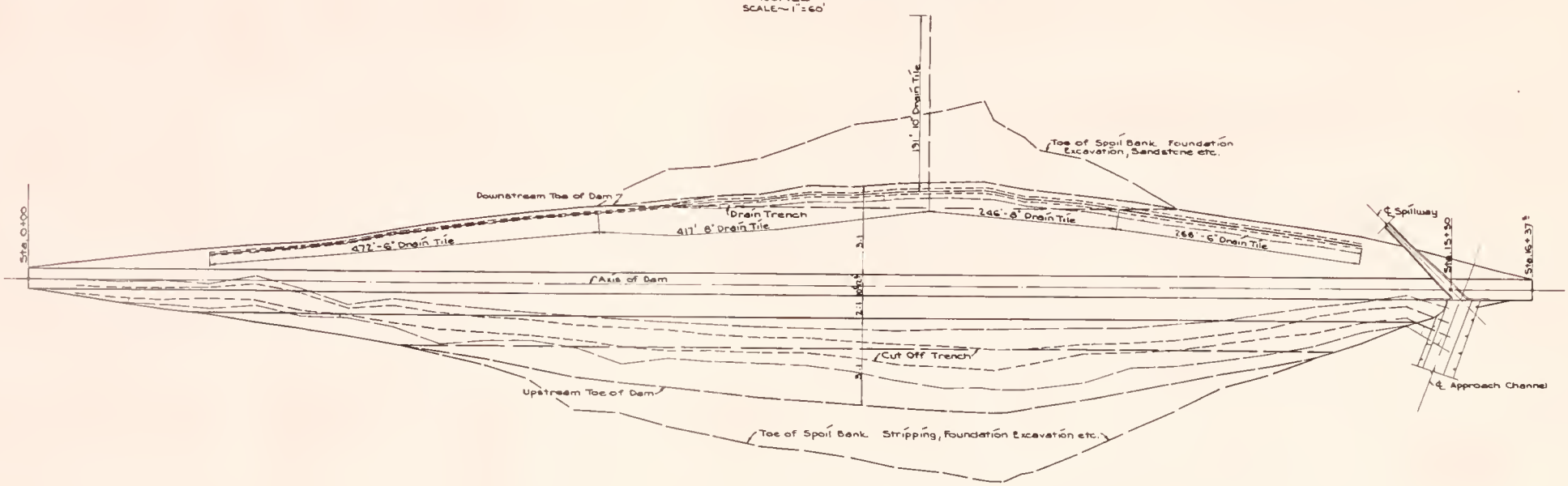
TYPICAL SECTION - NORTH DAM
SCALE — 1" = 20'

PROFILE & SECTION OF NORTH DAM AS CONSTRUCTED
UPPER MUSSELSHELL PROJECT
WHEATLAND & MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA — OCT 1939
SCALE AS SHOWN

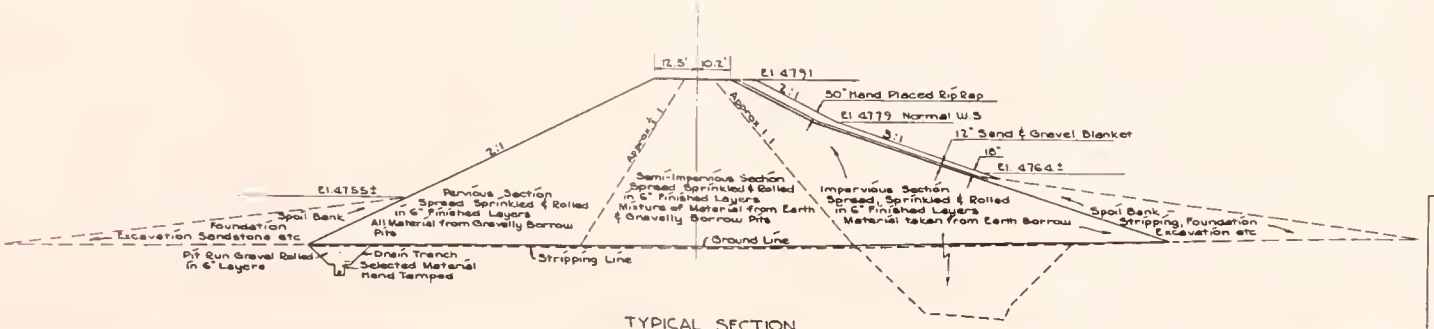
Drawn by	JCK				
Traced by	JCK				



PROFILE
SCALE ~ 1" = 60'



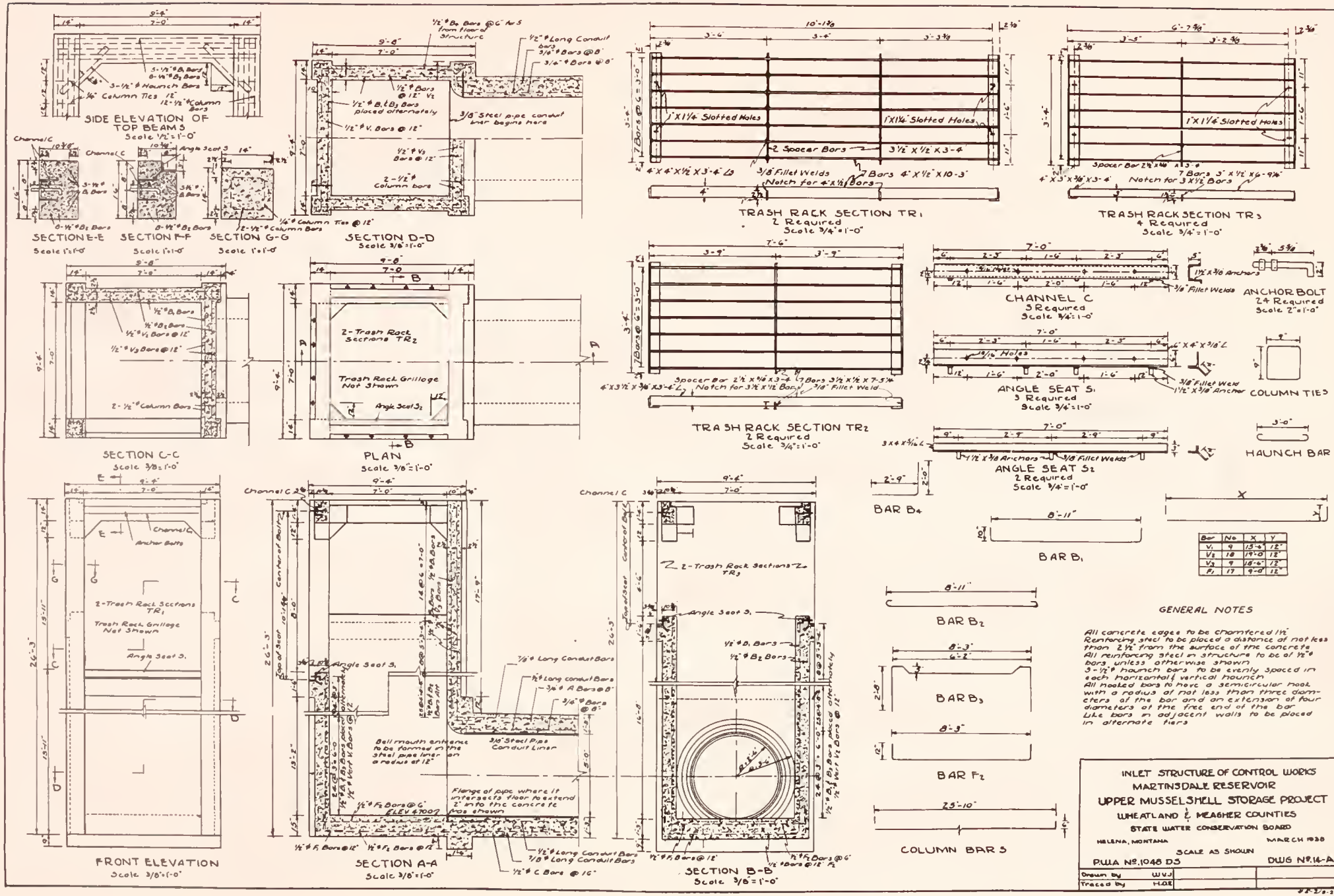
PLAN OF DAM
SCALE ~ 1" = 60'



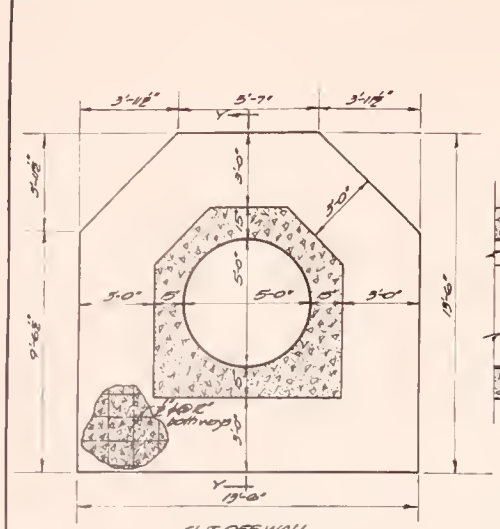
TYPICAL SECTION
SCALE ~ 1" = 20'

DETAILS OF SOUTH DAM AS CONSTRUCTED
UPPER MUSSELSHELL PROJECT
WHEATLAND & MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA NOV 1939
SCALE AS SHOWN

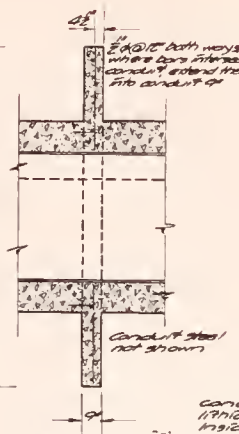
Drawn by	J.C.K.						
Traced by	J.C.K.						



Bar	No	X	Y
V1	9	13'-6"	12"
V2	18	19'-0"	12"
V3	9	18'-6"	12"
F1	17	9'-0"	12"



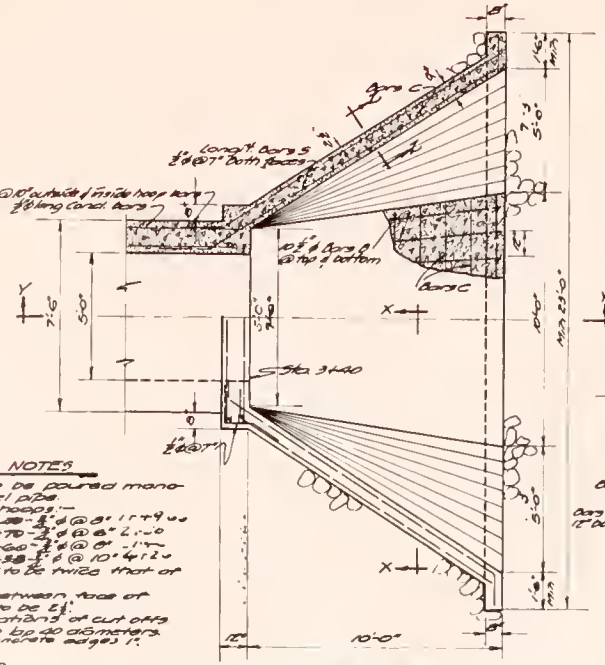
CUT-OFF WALL
Scale 3/8"=1'-0"



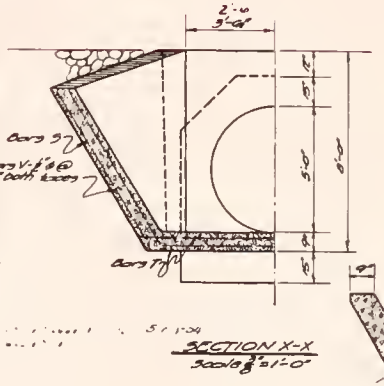
SECTION Y-Y
Scale 3/8"=1'-0"

GENERAL NOTES

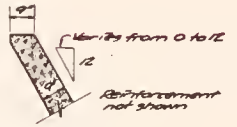
Conduit concrete to be poured monolithically around steel pipe. Inside and outside hoops:—
Sta. 0+00 to Sta. 1+88 - 3/8"ø @ 8" ctrs.
1+88 " " 2+70 - 3/8"ø @ 6" "
2+70 " " 3+60 - 3/8"ø @ 8" "
3+60 " " 4+38 - 3/8"ø @ 10" "
Spacing of 3/8"ø bars C to be twice that of hoop reinforcing.
Minimum distance between face of concrete and steel to be 1½".
See Dwg. No. 15 for locations of cut offs.
Long. conduit steel to be 20 diameters chamfer all exposed concrete edges 1".



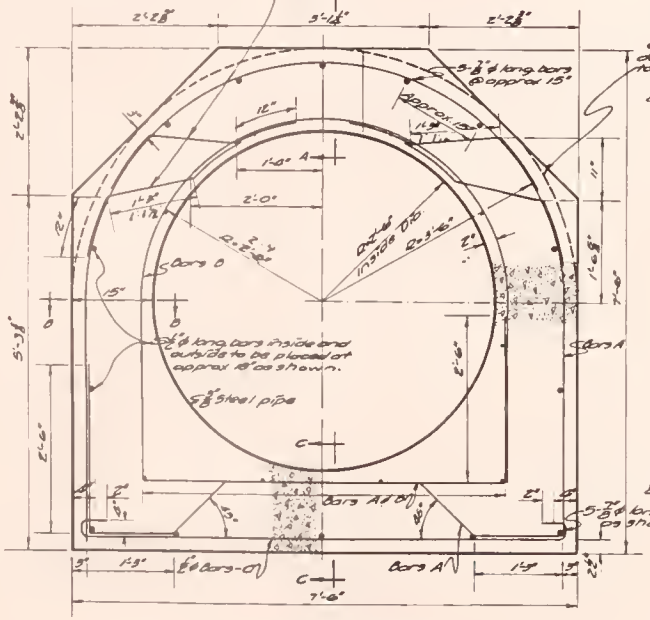
OUTLET STRUCTURE
PLAN & HORIZONTAL SECTION
Scale 3/8"=1'-0"



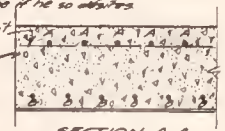
SECTION X-X
Scale 3/8"=1'-0"



SECTION Z-Z
Scale 3/8"=1'-0"

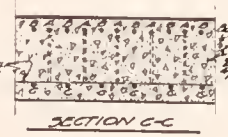


CONDUIT SECTION
Scale 1"=1'-0"



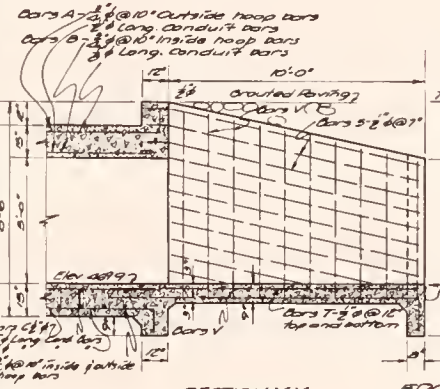
SECTION A-A

SECTION B-B

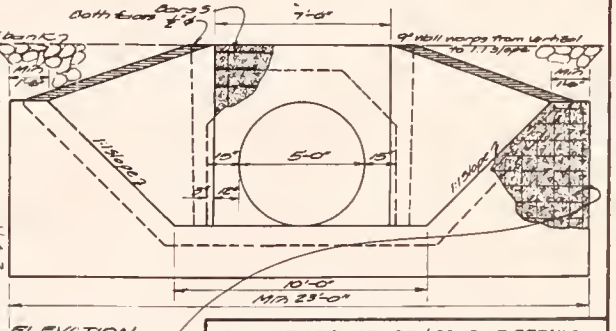


SECTION C-C

SECTIONS SHOWING PLACEMENT OF HOOP REINFORCING



SECTION Y-Y
Scale 3/8"=1'-0"

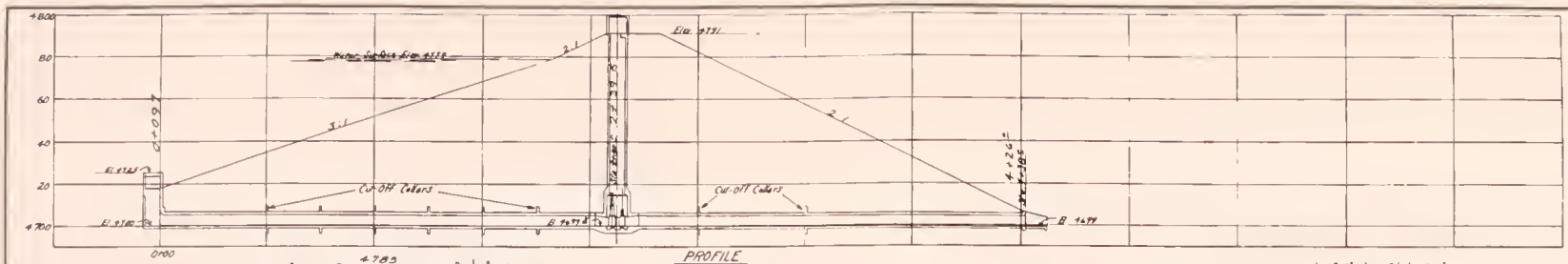


FRONT ELEVATION
Scale 3/8"=1'-0"

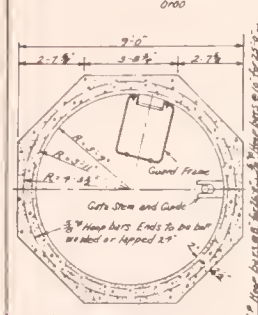
Note: Long'l bars 5 from opposed faces of winged wall bent horizontally into vertical wing wall. Bars 5 from left face bent down to outlet wall. Horiz. and vertical steel in middle of wall.

OUTLET STRUCTURE & CONDUIT DETAILS
OF CONTROL WORKS - MARTINSDALE RESERVOIR
UPPER MUSSELSHELL STORAGE PROJ.
WHEATLAND AND MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
Helena, Montana Feb. 22, 1935
Scale as shown
AWA. No. 1048 D3 Dwg. No. 16

Drawn by	S.W.	Traced by	M.B.	Checked by	
Revised by		Revised by		Revised by	



PROFILE
SCALE ~ 1" = 30'

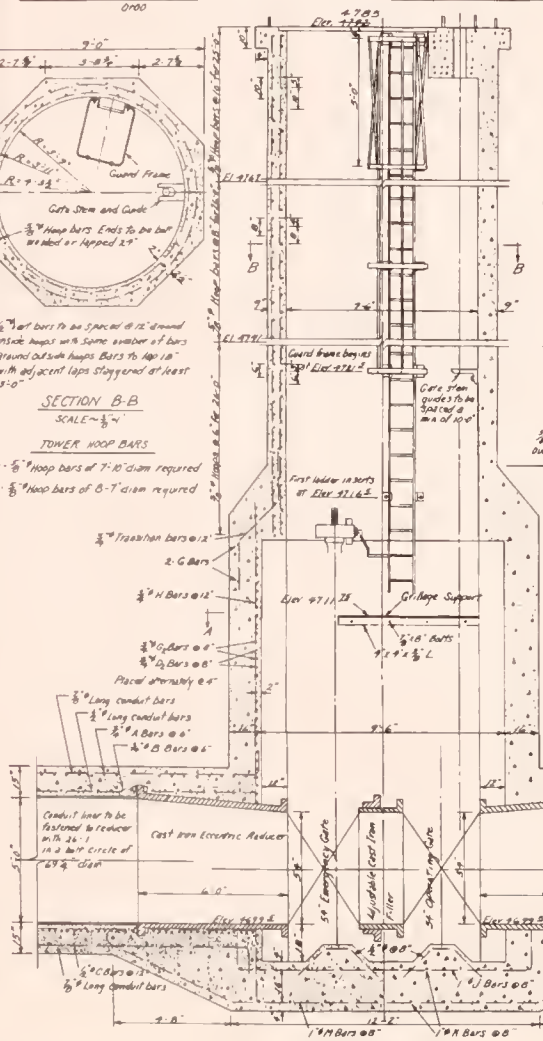


⅝" bar bars to be spaced @ 12" around inside hoops with same number of bars around outside hoops. Bars to lap 18" with adjacent laps staggered at least 3'-0"

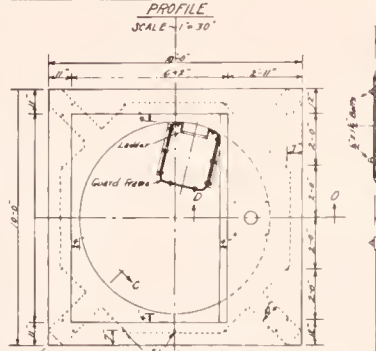
SECTION B-B
SCALE ~ ½" = 1'

TOWER HOOP BARS

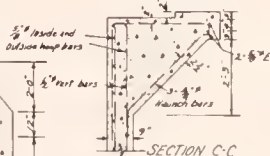
121 - ⅝" Hoop bars of 7'-10" diam required
121 - ⅝" Hoop bars of 8'-7" diam required


Elev. 4784
Guard frame bar ties
Gate stem guides to be spaced @ min of 10'-0"
First ladder inserts at Elev 4716.5
Grillage Support
Trashban bars @ 12"
2-G Bars
H Bars @ 12"
Placed alternately @ 6"
Long conduit bars
A Bars @ 6"
B Bars @ 6"
Conduit liner to be fastened to reducer with 36-1 in a bolt circle of 69¾" Diam
Cast iron Eccentric Reducer
5'-0" Emergency Gate
Adjustable Cast Iron Filler
5'-0" Cylinder Gate
C Bars @ 6"
Long conduit bars
J Bars @ 6"
M Bars @ 8"
R Bars @ 8"

SECTIONAL ELEVATION
SCALE ~ ½" = 1'

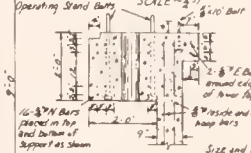


PLAN OF TOWER
SCALE ~ ½" = 1'



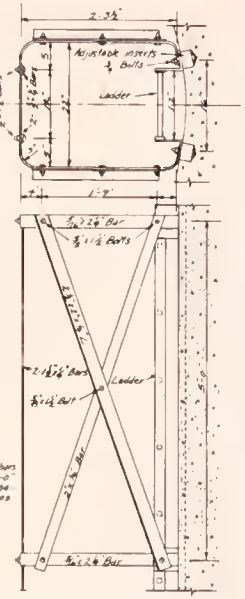
SECTION C-C
SCALE ~ ½" = 1'

Note:
Guard frame hoop bars to be spaced at 5'-0" with Cleats Bracing bar between two top hoops only

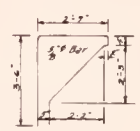

Operating Stand Bolts
1⅛" Bolt
2-E Bars around edge of floor top
⅝" Inside and outside hoop bars
16-N Bars placed in top and bottom of Support as shown

SECTION D-D
SCALE ~ ½" = 1'

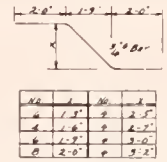
Size and location of operating Stand bolts and stem hole to be determined by gate manufacturer



PLAN AND SIDE ELEVATION OF GUARD FRAME
SCALE ~ 1" = 1'



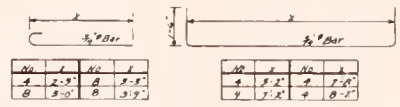
HAUNCH BAR
12 REQUIRED



No.	L	No.	L
A	2'-9"	B	3'-8"
B	3'-0"	B	3'-9"

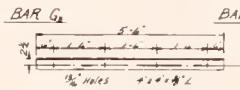
No.	L	No.	L
A	1'-3"	A	2'-3"
B	1'-6"	A	2'-7"
B	1'-7"	A	3'-0"
B	2'-0"	A	3'-2"

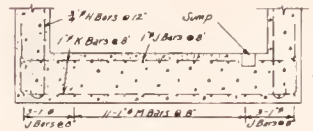
TRANSITION BAR



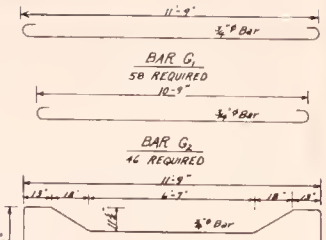
No.	L	No.	L
A	2'-9"	B	3'-8"
B	3'-0"	B	3'-9"

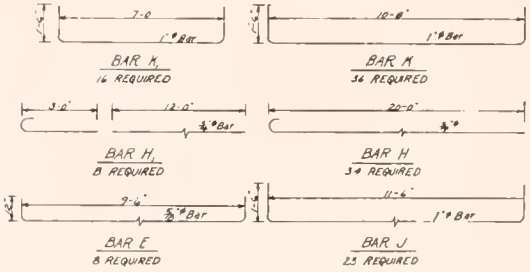
No.	L	No.	L
A	3'-2"	A	3'-8"
A	3'-3"	A	4'-0"
A	3'-4"	A	4'-2"
A	3'-5"	A	4'-3"

BAR G
BAR N

GRILLAGE SUPPORT
2 REQUIRED
SCALE ~ ½" = 1'



SECTION E-E
SCALE ~ ½" = 1'





GENERAL NOTES

Exposed concrete edges to be chamfered 1½"

Reinforcing steel to be placed a minimum distance of 2½" from the surface of the concrete unless otherwise shown

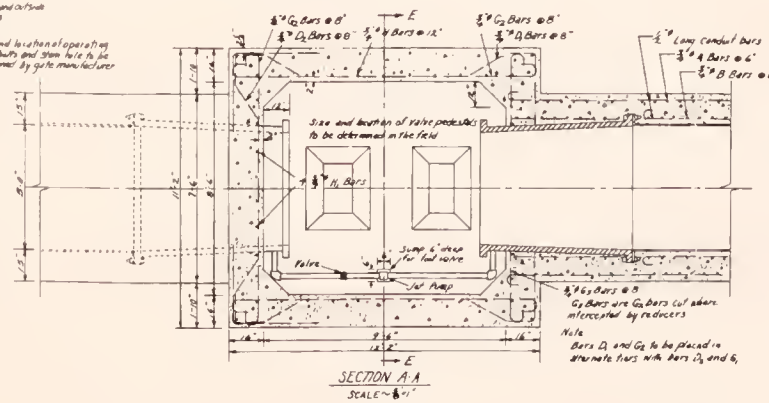
All hooked bars to have a semicircular hook with a radius not less than three diameters of the bar and an extension of four bar diameters at the free end of the bar

Ladder and guard frame to be placed as close to gate stem as operating stand support will permit as shown in PLAN OF TOWER

Inserts to be of a standard make and approved by the engineer

Conduit liner from inlet, including bell mouth entrance, to flange of upstream reducer requires a length of 220 ft. Conduit liner will be placed for 2 ft from flange of downstream transition

See Drawing No ___ for ladder and grillage details


G1 Bars @ 6"
D1 Bars @ 6"
E
H Bars @ 12"
G2 Bars @ 6"
D2 Bars @ 6"
Long conduit bars
A Bars @ 6"
B Bars @ 6"
Size and location of valve pedestals to be determined on the field
K Bars
Sump 6" deep for foot valve
Valve
Jet Pump
⅝" G2 Bars @ 6"
G1 Bars are G2 Bars cut where intercepted by reducers
E

Note
Bars D_1 and G_2 to be placed in alternate rows with Bars D_2 and G_1

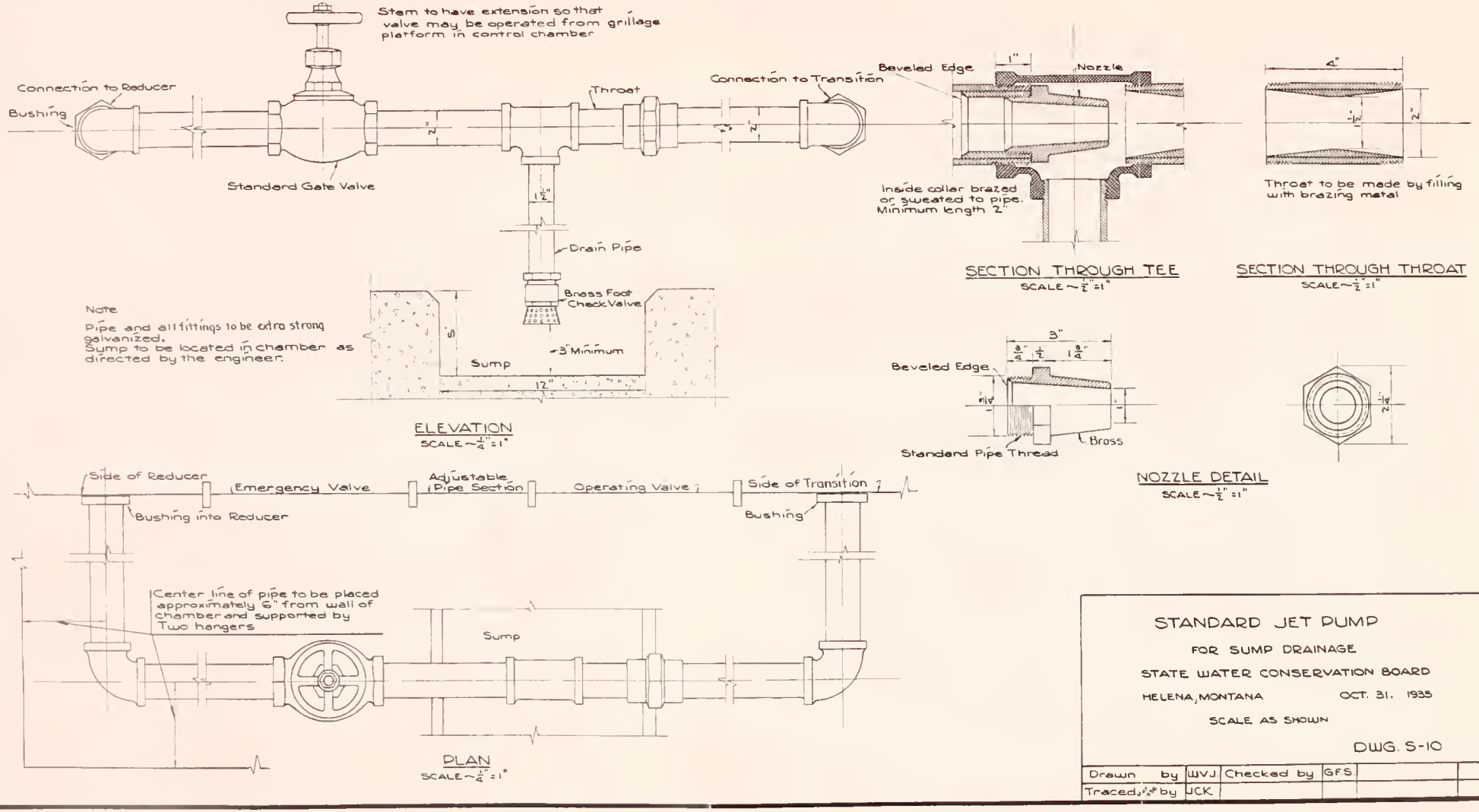
SECTION A-A
SCALE ~ ½" = 1'

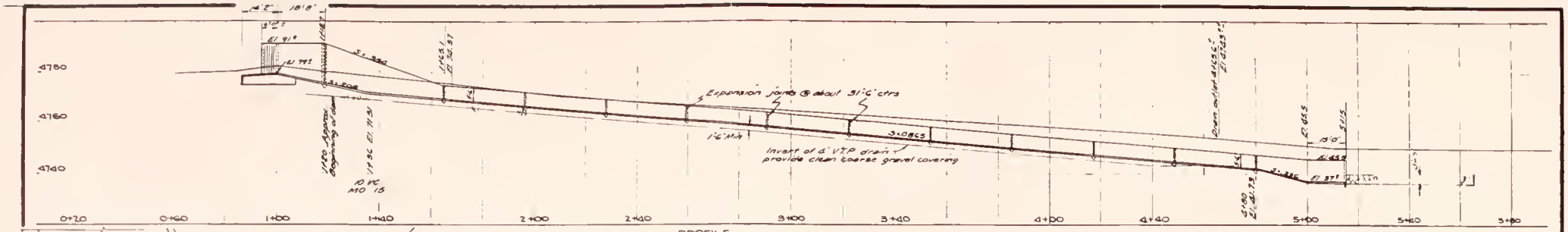
CONTROL CHAMBER AND TOWER OF CONTROL WORKS
MARTINSDALE RESERVOIR
UPPER MUSSELSHELL STORAGE PROJECT
MEAGHER AND WHEATLAND COUNTIES
STATE WATER CONSERVATION BOARD

HELENA, MONTANA — FEB 15, 1938
SCALE AS SHOWN

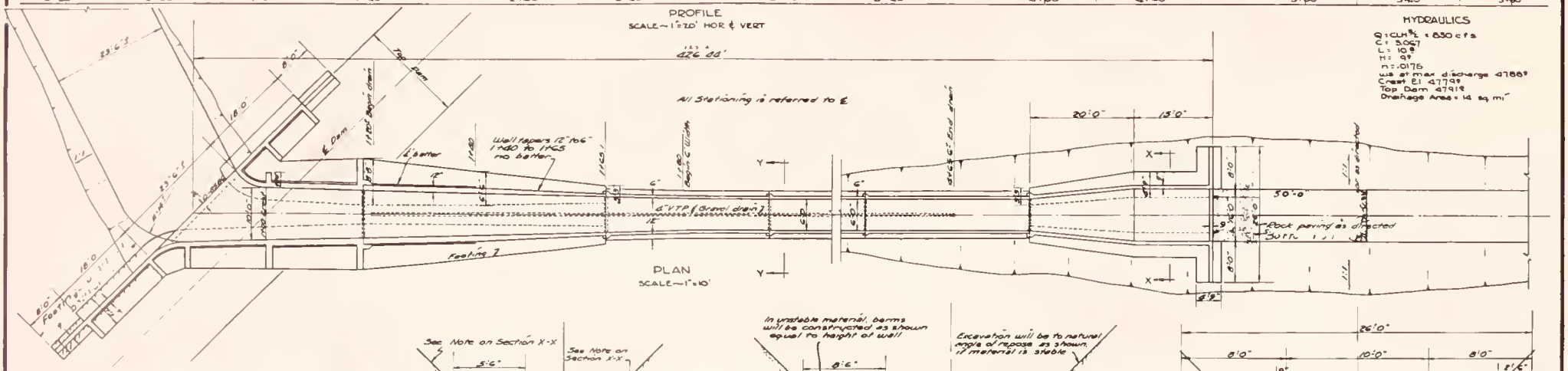
PWA NO 1048-DS — DRAWING NO 15

Drawn by WVJ


Stem to have extension so that valve may be operated from grillage platform in control chamber
Connection to Reducer
Bushing
Standard Gate Valve
Throat
Connection to Transition
Drain Pipe
Brass Foot Check Valve
Sump
3" Minimum
12"
Note
Pipe and all fittings to be extra strong galvanized.
Sump to be located in chamber as directed by the engineer.
ELEVATION
SCALE ~ 1/4" = 1"
Beveled Edge
1"
Nozzle
Inside collar brazed or sweated to pipe. Minimum length 2"
SECTION THROUGH TEE
SCALE ~ 1/2" = 1"
4"
Throat to be made by filling with brazing metal
SECTION THROUGH THROAT
SCALE ~ 1/2" = 1"
3"
Beveled Edge
Brass
Standard Pipe Thread
NOZZLE DETAIL
SCALE ~ 1/2" = 1"
Side of Reducer
Emergency Valve
Adjustable Pipe Section
Operating Valve
Side of Transition
Bushing into Reducer
Bushing
Center line of pipe to be placed approximately 6" from wall of chamber and supported by Two hangers
Sump
PLAN
SCALE ~ 1/4" = 1"
STANDARD JET PUMP
FOR SUMP DRAINAGE
STATE WATER CONSERVATION BOARD
HELENA, MONTANA
OCT. 31. 1935
SCALE AS SHOWN
DWG. S-10
Drawn by WVJ. Checked by GFS
Traced by JCK

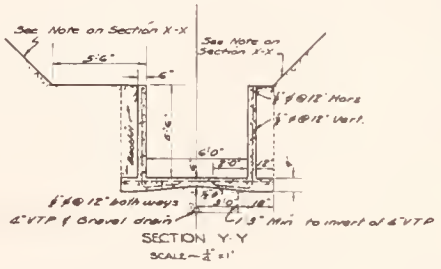


PROFILE
SCALE — 1" = 20' HOR & VERT

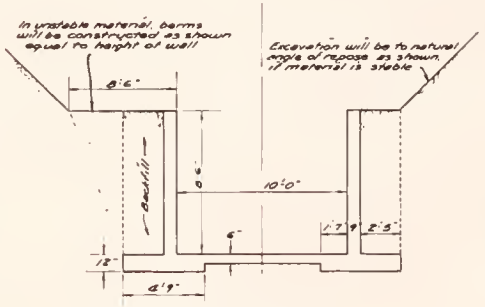


PLAN
SCALE — 1" = 10'

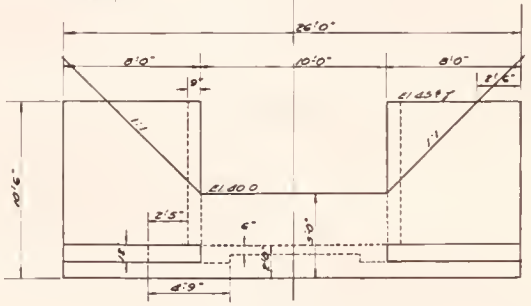
HYDRAULICS
Q = CLH^3/2 = 830 cfs
C = 3.067
L = 10'
H = 9'
n = .0175
Q at max discharge 4788'
Crest El 4779'
Top Dam 4791'
Drainage Area = 14 sq mi



SECTION Y-Y
SCALE — 1/4" = 1'


In unstable material, berms will be constructed as shown equal to height of wall
Excavation will be to natural angle of repose as shown, if material is stable
Backfill
10'-0"

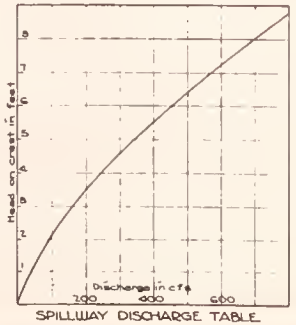
SECTION X X
SCALE — 1/4" = 1'



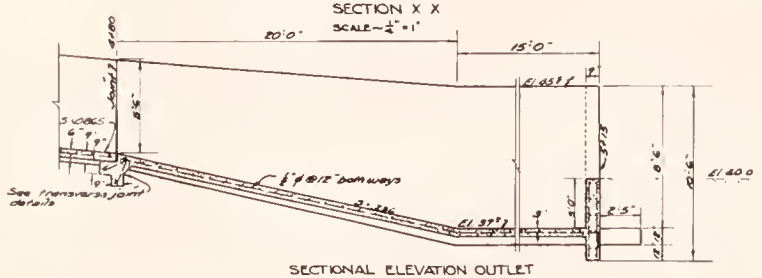
DOWNSTREAM ELEVATION
SCALE — 1/4" = 1'

SPILLWAY DATA

Station	Point	Width	Elevation Floor	Elevation Wall
0+85.9		23.5'	47.78'	47.91'
1+00	Crest	10.0	79'	91'
1+18.7	Begin Sloped Top wall	-	-	9'5
1+20		9.0	74.84	-
1+31	Gr PC	-	72.55	-
1+36	Gr PI.	-	71.66	-
1+40		8.0	71.16	89.46
1+41	Gr PT	-	71.08	-
1+60		7.0	69.43	-
1+63.1		-	-	74.57
1+80		6.0	67.70	73.20
2+00		-	65.97	71.47
2+50		-	61.65	67.15
3+00		-	57.32	62.82
3+50		-	53.00	58.50
4+00		-	48.67	54.17
4+50		-	44.35	49.85
4+80		6.0	41.75	47.25
5+00		10.0	37.00	45.50
5+14.3		10.0	37.00	45.50
5+15.0	End	10.0	40.00	45.50



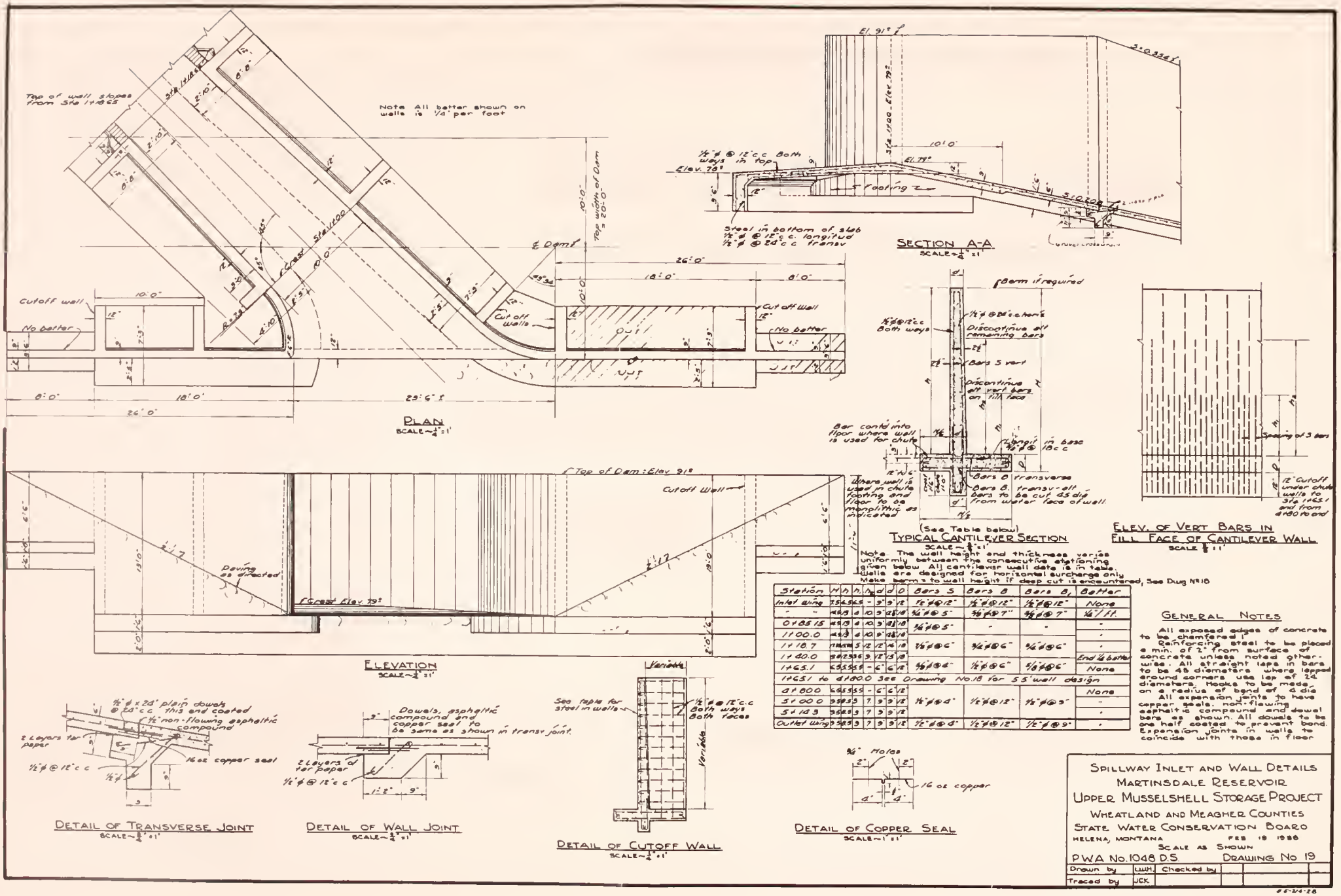
SPILLWAY DISCHARGE TABLE

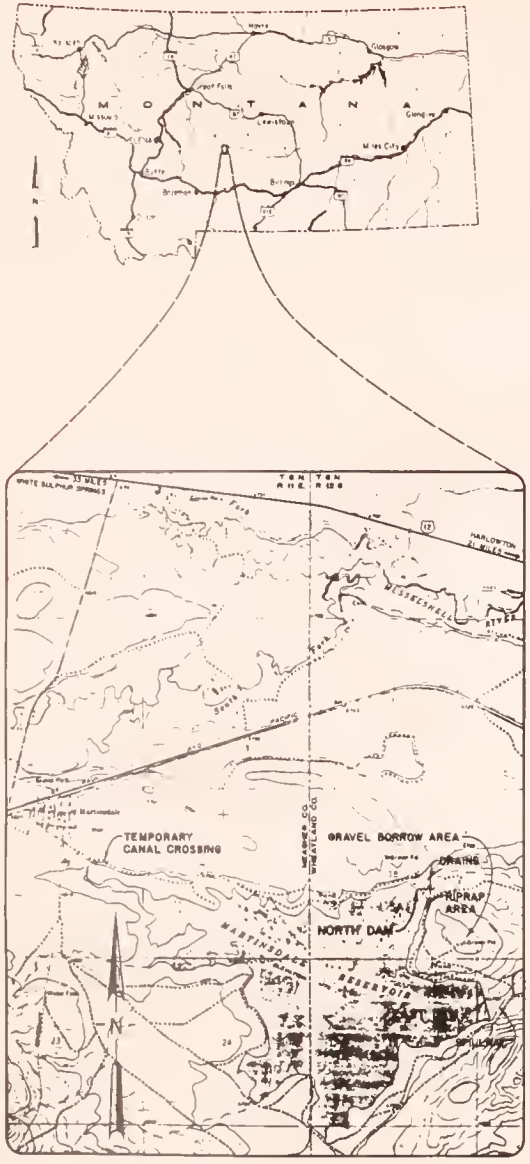


SECTIONAL ELEVATION OUTLET
SCALE — 1/4" = 1'

SPILLWAY PLAN, PROFILE & OUTLET DETAILS
MARTINSDALE DAM
UPPER MUSSELSHELL STORAGE PROJECT
WHEATLAND & MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA
FEB 1958
SCALE AS SHOWN
PWA No 1048 D.S
DRAWING No 18

Drawn by	C.B	Checked by		
Traced by	JCK			


Top of wall slopes from Sta 1+18.65
Note All batter shown on walls is 1/4" per foot
Top width of Dam = 20'-0"
℄ Dam
Cutoff wall
No batter
Cut off Wall
Cross Slopes
PLAN
SCALE 1/4" = 1'
SECTION A-A
SCALE 1/4" = 1'
Top of Dam: Elev. 91'
Cutoff Wall
Paving as directed
Crest Elev. 79'
ELEVATION
SCALE 1/4" = 1'
Bar if required
Discontinue all remaining bars
Bars S vert
Discontinue all vert bars on fill face
Bar cont'd into flor where wall is used for chute
Where wall is used in chute footing and floor to be monolithic as indicated
Bars B transverse
Bars B, transv - all bars to be cut 45 deg from water face of wall.
(See Table below)
TYPICAL CANTILEVER SECTION
SCALE 1/4" = 1'
Spacing of 3 bars
12" Cutoff under chute walls fr Sta 1+65.1 and from 4+80 to end
ELEV. OF VERT BARS IN FILL FACE OF CANTILEVER WALL
SCALE 1/4" = 1'
Note The wall height and thickness varies uniformly between the consecutive stationing given below. All cantilever wall data is in table. Walls are designed for horizontal surcharge only. Make berm = to wall height if deep cut is encountered, See Dwg No 18
Station | H | h | h1 | h2 | d | d1 | D | Bars S | Bars B | Bars B1 | Batter
Inlet Wing | 7.5 | 4.5 | 6.5 | - | 2' | 3' | 12" | 1/2" ℄ @ 12" | 1/2" ℄ @ 12" | 1/2" ℄ @ 12" | None
" | " | 4.8 | 3 | 4 | 10 | 2' | 8 1/2" | 1/2" ℄ @ 5" | 5/8" ℄ @ 7" | 5/8" ℄ @ 7" | 1/4" / ft.
0+88.15 | 4.9 | 3 | 4 | 10 | 2' | 8 1/2" | 10 | 1/2" ℄ @ 5" | - | - | "
1+00.0 | 4.8 | 3 | 4 | 10 | 2' | 8 1/2" | 10 | " | " | " | "
1+18.7 | 11.8 | 8 | 5 | 12 | 2' | 9 1/2" | 10 | 1/2" ℄ @ 6" | 5/8" ℄ @ 6" | 5/8" ℄ @ 6" | "
1+40.0 | 14.2 | 9 | 5 | 12 | 2' | 9 1/2" | 10 | " | " | " | End 1/4 batter
1+65.1 | 13.5 | 8.5 | 5 | - | 6" | 2' | 12" | 5/8" ℄ @ 4" | 1/2" ℄ @ 6" | 5/8" ℄ @ 6" | None
1+65.1 to 4+80.0 See Drawing No. 18 for S.S wall design
4+80.0 | 6.8 | 3.8 | 5.5 | - | 6" | 2' | 12" | | | | None
5+00.0 | 9.9 | 5.5 | 7 | 3 | 2' | 3' | 12" | 1/2" ℄ @ 4" | 1/2" ℄ @ 12" | 5/8" ℄ @ 9" | "
5+18.3 | 9.5 | 5.3 | 7 | 3 | 2' | 3' | 12" | | | | "
Outlet wing | 9.5 | 5.3 | 7 | 3 | 2' | 3' | 12" | 1/2" d @ 9" | 1/2" ℄ @ 12" | 1/2" ℄ @ 9" | "
GENERAL NOTES
All exposed edges of concrete to be chamfered 1"
Reinforcing steel to be placed a min. of 2" from surface of concrete unless noted otherwise. All straight laps in bars to be 48 diameters, where lapped around corners use lap of 24 diameters. Hooks to be made on a radius of bend of 4 dia
All expansion joints to have copper seals, non-flowing asphaltic compound and dowel bars as shown. All dowels to be one half coated to prevent bond. Expansion joints in walls to coincide with those in floor
1/2" ℄ x 24" plain dowels @ 24" c.c. this end coated
1/2" non-flowing asphaltic compound
2 Layers tar paper
16 oz copper seal
1/2" ℄ @ 12" c.c
DETAIL OF TRANSVERSE JOINT
SCALE 1/4" = 1'
Dowels, asphaltic compound and copper seal to be same as shown in transv joint.
DETAIL OF WALL JOINT
SCALE 1/4" = 1'
See table for steel in walls
Variable
1/2" ℄ @ 12" c.c Both ways Both faces
DETAIL OF CUTOFF WALL
SCALE 1/4" = 1'
1/2" Holes
16 oz copper
DETAIL OF COPPER SEAL
SCALE 1" = 1'
SPILLWAY INLET AND WALL DETAILS
MARTINSDALE RESERVOIR
UPPER MUSSELSHELL STORAGE PROJECT
WHEATLAND AND MEAGHER COUNTIES
STATE WATER CONSERVATION BOARD
HELENA, MONTANA
FEB 19 1936
SCALE AS SHOWN
P.W.A. No. 1048 D.S.
DRAWING No 19
Drawn by LWH. Checked by
Traced by JCK.



LOCATION MAP

2000 0 2000 4000
Scale Feet

CONSTRUCTION PLANS

OF

MARTINSDALE DAM

REHABILITATION PROJECT

Prepared for :

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
and
UPPER MUSSELSHELL WATER USERS ASSOCIATION

AS BUILT

Prepared by :

HKM ASSOCIATES
ENGINEERS · PLANNERS

P. O. Box 31318
Airport Industrial Park
Billings, Montana 59107

8M087.120

JUNE 1985

PRINCIPAL IN CHARGE, P.E., 1998E

Roger Perkins
PROJECT ENGINEER, P.E., 4340E

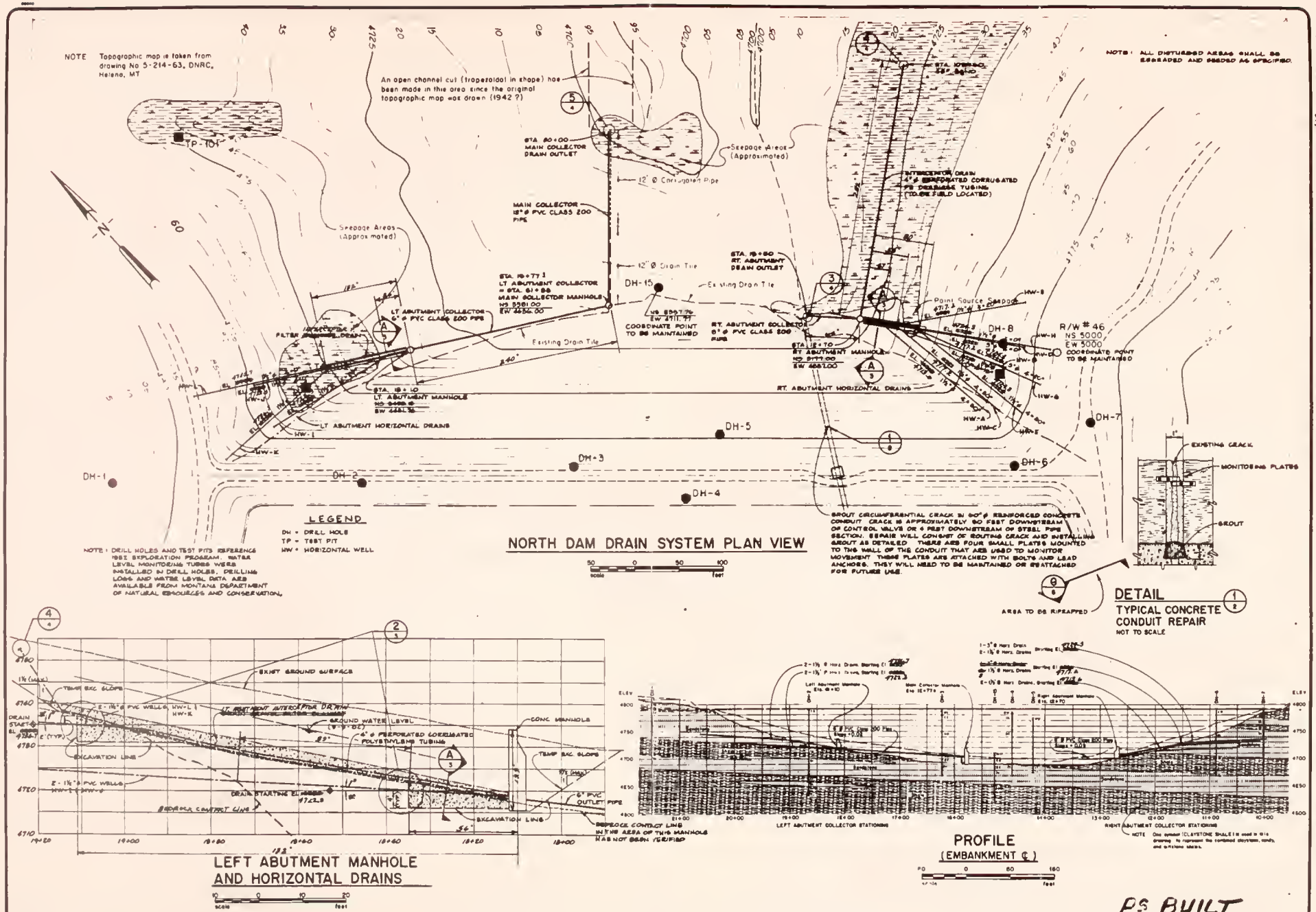
Approved by :

CHIEF, ENGINEERING BUREAU
MONTANA DEPARTMENT OF
NATURAL RESOURCES AND CONSERVATION

INDEX OF DRAWINGS

SHEET NO.	TITLE
1.	COVER SHEET
2.	NORTH DAM DRAIN SYSTEM PLAN & PROFILES
3.	NORTH DAM DRAIN SYSTEM PROFILES & DETAILS
4.	NORTH DAM DRAIN SYSTEM DETAILS
5.	EAST DAM SPILLWAY PLAN, SECTION & DETAILS
6.	EAST DAM SITE GRADING PLAN & SECTIONS and NORTH DAM AREA RIPRAP SECTION & LOGS OF EXPLORATION HOLES

5-214-97
W/ch order
#1 attached


NOTE Topographic map is taken from drawing No 5-214-63, DNRC, Helena, MT
An open channel cut (trapezoidal in shape) has been made in this area since the original topographic map was drawn (1942 ?)
NOTE: ALL DISTURBED AREAS SHALL BE SEEDBEDED AND SEEDED AS SPECIFIED.
TP-101
STA. 80+00 MAIN COLLECTOR DRAIN OUTLET
Seepage Areas (Approximated)
12" Ø Corrugated Pipe
MAIN COLLECTOR 18" Ø PVC CLASS 200 PIPE
INTERCEPTOR DRAIN 2" Ø PERFORATED CORRUGATED PE DRAINAGE TUBING (FIELD LOCATED)
Seepage Areas (Approximated)
12" Ø Drain Tile
STA. 19+60 RT. ABUTMENT DRAIN OUTLET
STA. 19+77.3 LT ABUTMENT COLLECTOR = STA. 61+88 MAIN COLLECTOR MANHOLE NS 5381.00 EW 4652.00
DH-15
Existing Drain Tile
COORDINATE POINT TO BE MAINTAINED
RT. ABUTMENT COLLECTOR 6" Ø PVC CLASS 200 PIPE
Point Source Seepage
DH-8
R/W # 46 NS 5000 EW 5000 COORDINATE POINT TO BE MAINTAINED
LT ABUTMENT COLLECTOR 6" Ø PVC CLASS 200 PIPE
INTERCEPTOR DRAIN
Existing Drain Tile
STA. 18+10 LT. ABUTMENT MANHOLE NS 5488.6 EW 4681.96
STA. 18+70 RT ABUTMENT MANHOLE NS 5477.00 EW 4685.00
RT. ABUTMENT HORIZONTAL DRAINS
LT ABUTMENT HORIZONTAL DRAINS
DH-1
DH-2
DH-3
DH-4
DH-5
DH-6
DH-7
LEGEND
DH = DRILL HOLE
TP = TEST PIT
HW = HORIZONTAL WELL
NOTE: DRILL HOLES AND TEST PITS REFERENCE 1982 EXPLORATION PROGRAM. WATER LEVEL MONITORING TUBES WERE INSTALLED IN DRILL HOLES. DRILLING LOGS AND WATER LEVEL DATA ARE AVAILABLE FROM MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION.
NORTH DAM DRAIN SYSTEM PLAN VIEW
scale 50 0 50 100 feet
GROUT CIRCUMFERENTIAL CRACK IN 90" Ø REINFORCED CONCRETE CONDUIT. CRACK IS APPROXIMATELY 80 FEET DOWNSTREAM OF CONTROL VALVE OR 4 FEET DOWNSTREAM OF STEEL PIPE SECTION. REPAIR WILL CONSIST OF ROUTING CRACK AND INSTALLING GROUT AS DETAILED. THERE ARE FOUR SMALL PLATES MOUNTED TO THE WALL OF THE CONDUIT THAT ARE USED TO MONITOR MOVEMENT. THESE PLATES ARE ATTACHED WITH BOLTS AND LEAD ANCHORS. THEY WILL NEED TO BE MAINTAINED OR REATTACHED FOR FUTURE USE.
AREA TO BE RIPRAPPED
EXISTING CRACK
MONITORING PLATES
GROUT
DETAIL
TYPICAL CONCRETE CONDUIT REPAIR
NOT TO SCALE
EXIST GROUND SURFACE
TEMP EXC SLOPE
GROUND WATER LEVEL
CONC. MANHOLE
EXCAVATION LINE
DRAIN STARTING EL.
BEDROCK CONTACT LINE
6" PVC OUTLET PIPE
LEFT ABUTMENT MANHOLE AND HORIZONTAL DRAINS
scale 0 10 20 feet
PROFILE
(EMBANKMENT ℄)
LEFT ABUTMENT COLLECTOR STATIONING
RIGHT ABUTMENT COLLECTOR STATIONING
scale 0 80 160 feet
AS BUILT

Project No 88087.120 I.D No — Date MAY 1988 Designed/DP Drawn/MF Checked/AF Approved

No	Revision	By	Date

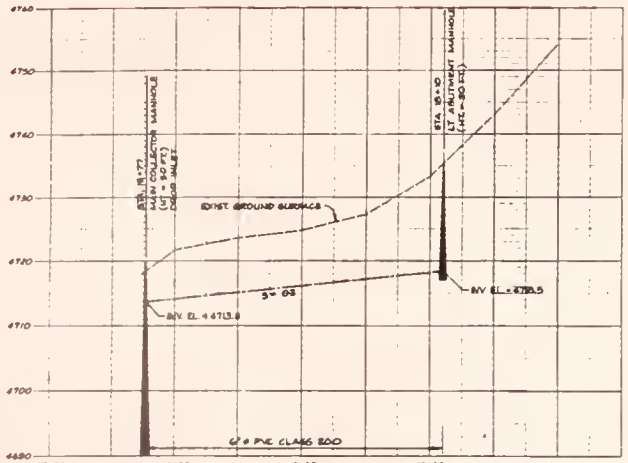
MARTINSDALE DAM
REHABILITATION PROJECT

NORTH DAM DRAIN SYSTEM PLAN & PROFILES

MONTANA REGISTERED PROFESSIONAL ENGINEER

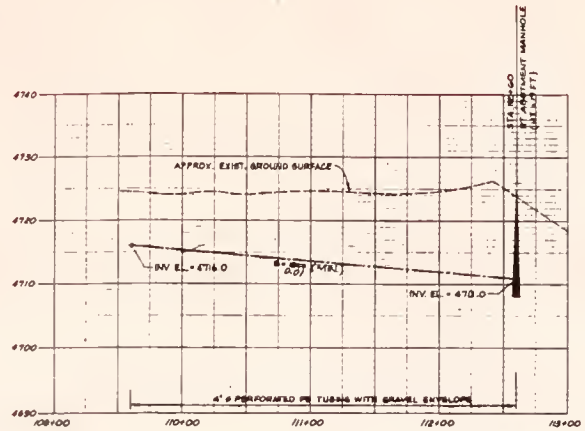
HKM ASSOCIATES
ENGINEERS • PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices: • Libby, Montana • Sheridan, Wyoming

Sheet No 2 of 6



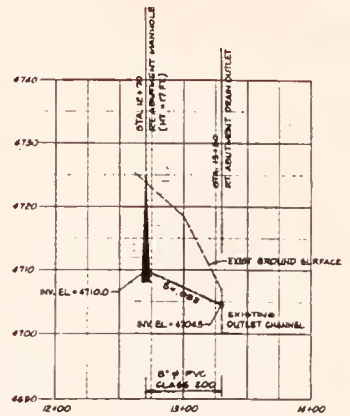
NOTE: MIN. SLOPE = .02
MIN. COVER = 8 FT

LEFT ABUTMENT COLLECTOR

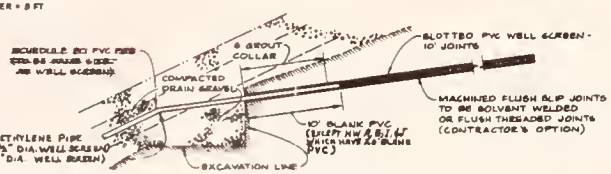


NOTE: FINAL ALIGNMENT AND GRADE OF INTERCEPTOR DRAIN TO BE FIELD DIRECTED BY ENGINEER
MIN. SLOPE = .01
MIN. COVER = 4 FT

INTERCEPTOR DRAIN

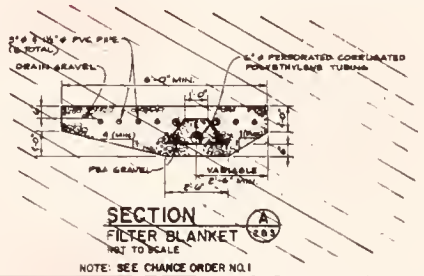


RIGHT ABUTMENT COLLECTOR


SCHEDULE 80 PVC PIPE
6" GROUT COLLAR
COMPACTED DRAIN GRAVEL
SLOTTED PVC WELL SCREEN - 10' JOINTS
MACHINED FLUSH SLIP JOINTS TO BE SOLVENT WELDED OR FLUSH THREADED JOINTS (CONTRACTOR'S OPTION)
10' BLANK PVC
EXCAVATION LINE

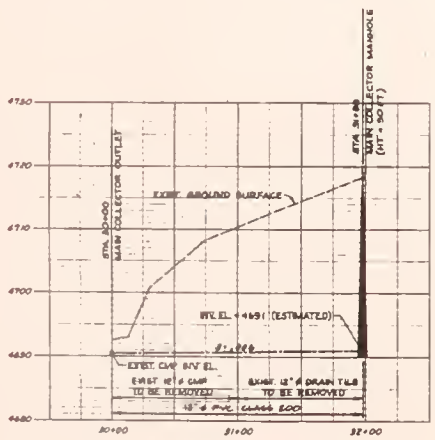
NOMINAL Polyethylene Pipe
6" - 2" DIA. FOR 1/8" DIA. WELL SCREEN
4" DIA. FOR .3" DIA. WELL SCREEN

DETAIL (TYPICAL) (2)
HORIZONTAL WELL COMPLETION 283
NOT TO SCALE



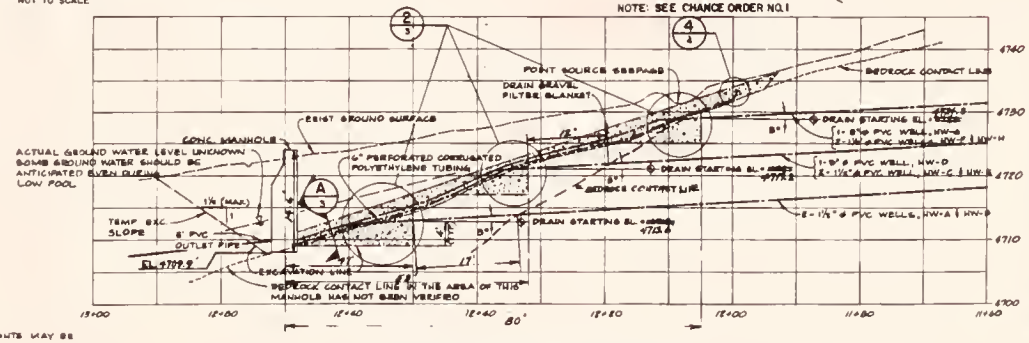
SECTION (A)
FILTER BLANKET 283
NOT TO SCALE

NOTE: SEE CHANGE ORDER NO. 1


EXIST GROUND SURFACE
INV. EL. = 4691 (ESTIMATED)
EXIST. CMP INV EL.
EXIST 12" ø CMP TO BE REMOVED
EXIST 12" ø DRAIN TILE TO BE REMOVED
48" ø PVC CLASS 200

NOTE: MAIN COLLECTOR ALIGNMENT AND GRADE SHALL MATCH THAT OF THE EXISTING CORRUGATED PIPE AND DRAIN TILE. ACTUAL LOCATION SHALL BE DETERMINED WHILE REMOVING EXISTING LINE. EXISTING TOE DRAINS SHALL BE CONNECTED TO MAIN COLLECTOR MANHOLE. MAIN COLLECTOR MANHOLES SHALL BE LOCATED AT THE INTERSECTION OF EXISTING TOE DRAINS.

MAIN COLLECTOR


POINT SOURCE SEEPAGE
DRAIN GRAVEL FILTER BLANKET
BEDROCK CONTACT LINE
EXIST GROUND SURFACE
CONC. MANHOLE
ACTUAL GROUND WATER LEVEL UNKNOWN SOME GROUND WATER SHOULD BE ANTICIPATED EVEN DURING LOW FLOW
6" PERFORATED CORRUGATED POLYETHYLENE TUBING
TEMP. EXC. SLOPE
6" PVC OUTLET PIPE
EXCAVATION LINE
BEDROCK CONTACT LINE IN THE AREA OF THIS MANHOLE HAS NOT BEEN VERIFIED
E - 1½" ø PVC WELLS, HW-A & HW-B
80'

NOTE: FINAL MANHOLE HEIGHTS MAY BE ADJUSTED DURING CONSTRUCTION

RIGHT ABUTMENT MANHOLE AND HORIZONTAL DRAINS

AS BUILT

5-214-99
E31

MARTINSDALE DAM
REHABILITATION PROJECT

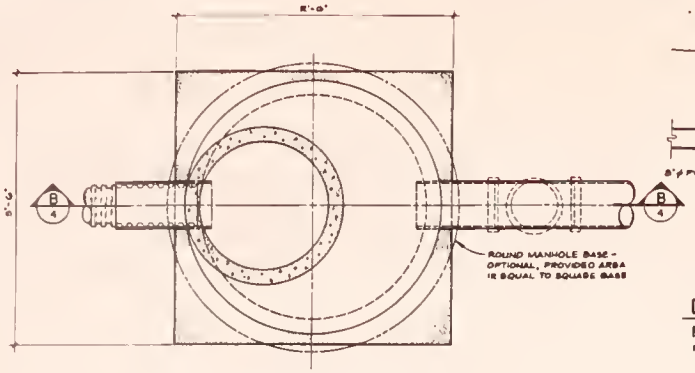
NORTH DAM DRAIN SYSTEM PROFILES & DETAILS

Project No. 84087.120 I.D. No. Date MAY 1985 Designed JT. Drawn JAC Checked RJE Approved

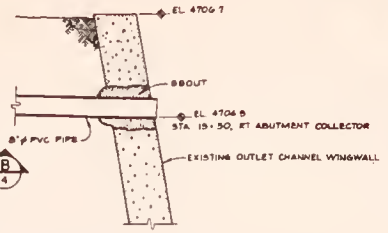
No	Revision	By	Date

HKM ASSOCIATES
ENGINEERS-PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

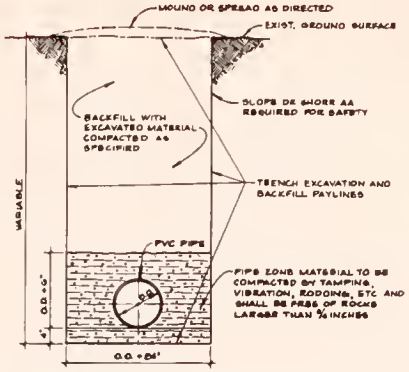
Sheet No. 3 of 6



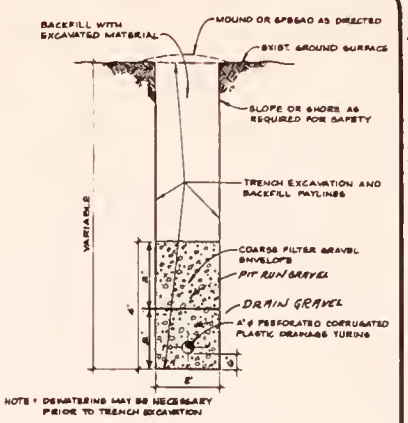
PLAN OF MANHOLE
NOT TO SCALE



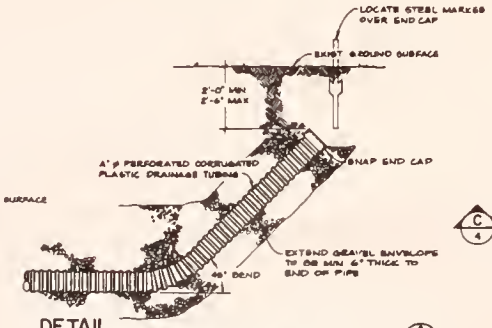
DETAIL
RIGHT ABUTMENT DRAIN OUTLET (3/2)
NOT TO SCALE


MOUND OR SPREAD AS DIRECTED
EXIST. GROUND SURFACE
BACKFILL WITH EXCAVATED MATERIAL COMPACTED AS SPECIFIED
SLOPE OR SHORE AS REQUIRED FOR SAFETY
TRENCH EXCAVATION AND BACKFILL PAYLINES
VARIABLE
PVC PIPE
FIPS ZONE MATERIAL TO BE COMPACTED BY TAMPING, VIBRATION, RODDING, ETC. AND SHALL BE FREE OF ROCKS LARGER THAN ¾ INCHES
O.D. + 6"
O.D. + 24"

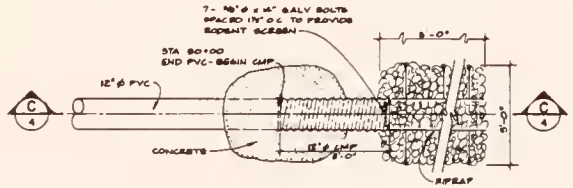
TYPICAL TRENCH
FOR COLLECTOR DRAINS
NOT TO SCALE



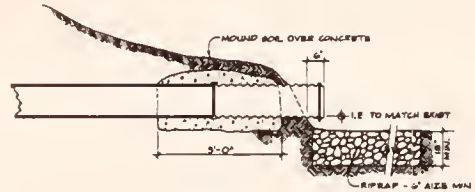
INTERCEPTOR DRAIN TRENCH
NOT TO SCALE


LOCATE STEEL MARKER OVER END CAP
EXIST. GROUND SURFACE
2'-0" MIN
2'-6" MAX
4"ϕ PERFORATED CORRUGATED PLASTIC DRAINAGE TUBING
SNAP END CAP
EXTEND GRAVEL ENVELOPE TO BE MIN 6" THICK TO END OF PIPE
45° BEND

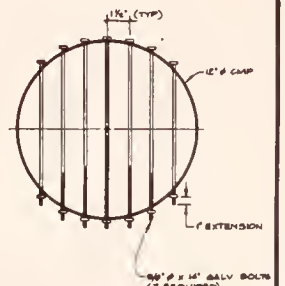
DETAIL
BLANKET DRAIN & INTERCEPTOR DRAIN END (4/2&3)
NOT TO SCALE



PLAN VIEW

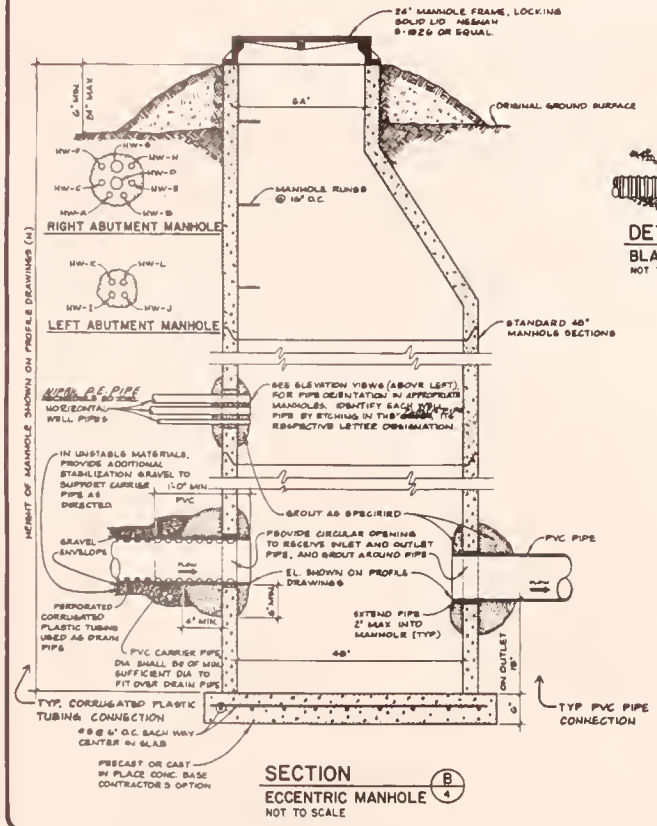


SECTION
C
4

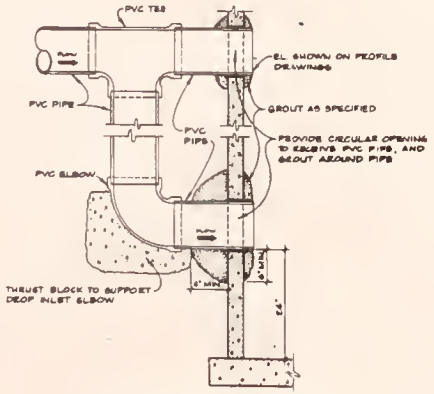


END VIEW

DETAIL
MAIN COLLECTOR DRAIN OUTLET (5/2)
NOT TO SCALE


24" MANHOLE FRAME, LOCKING SOLID LID NEENAH R-1826 OR EQUAL
6" MIN
24" MAX
84"
ORIGINAL GROUND SURFACE
HW-F
HW-G
HW-H
HW-D
HW-C
HW-B
HW-A
HW-B
RIGHT ABUTMENT MANHOLE
MANHOLE RUNGS @ 16" O.C.
HW-K
HW-L
HW-I
HW-J
LEFT ABUTMENT MANHOLE
STANDARD 48" MANHOLES SECTIONS
HEIGHT OF MANHOLE SHOWN ON PROFILE DRAWINGS (H)
SEE ELEVATION VIEWS (ABOVE LEFT) FOR PIPE ORIENTATION IN APPROPRIATE MANHOLES. IDENTIFY EACH HW-PIPE BY ETCHING IN THE RESPECTIVE LETTER DESIGNATION.
HW-PIPE
HORIZONTAL WELL PIPES
IN UNSTABLE MATERIALS, PROVIDE ADDITIONAL STABILIZATION GRAVEL TO SUPPORT CARRIER PIPE AS DIRECTED
1'-0" MIN
PVC
GRAVEL ENVELOPE
GROUT AS SPECIFIED
PROVIDE CIRCULAR OPENING TO RECEIVE INLET AND OUTLET PIPE, AND GROUT AROUND PIPE
PVC PIPE
EL. SHOWN ON PROFILE DRAWINGS
EXTEND PIPE 2" MAX INTO MANHOLE (TYP)
PERFORATED CORRUGATED PLASTIC TUBING USED AS DRAIN PIPE
PVC CARRIER PIPE, DIA SHALL BE OF MIN. SUFFICIENT DIA TO FIT OVER DRAIN PIPE
48"
ON OUTLET
TYP. CORRUGATED PLASTIC TUBING CONNECTION
#5 @ 6" O.C. EACH WAY CENTER IN SLAB
PRECAST OR CAST-IN PLACE CONC. BASE CONTRACTOR'S OPTION
TYP PVC PIPE CONNECTION

SECTION
ECCENTRIC MANHOLE (B/4)
NOT TO SCALE



DROP INLET DETAIL
MAIN COLLECTOR MANHOLE
NOT TO SCALE

H. E WILT

E33 5-214-RC

Project No BM027.120 I.D. No — Date MAY 1988 Designed JT Drawn JAC Checked RLP Approved

No	Revision	By	Date

MARTINSDALE DAM
REHABILITATION PROJECT

NORTH DAM DRAIN SYSTEM DETAILS

HKM ASSOCIATES
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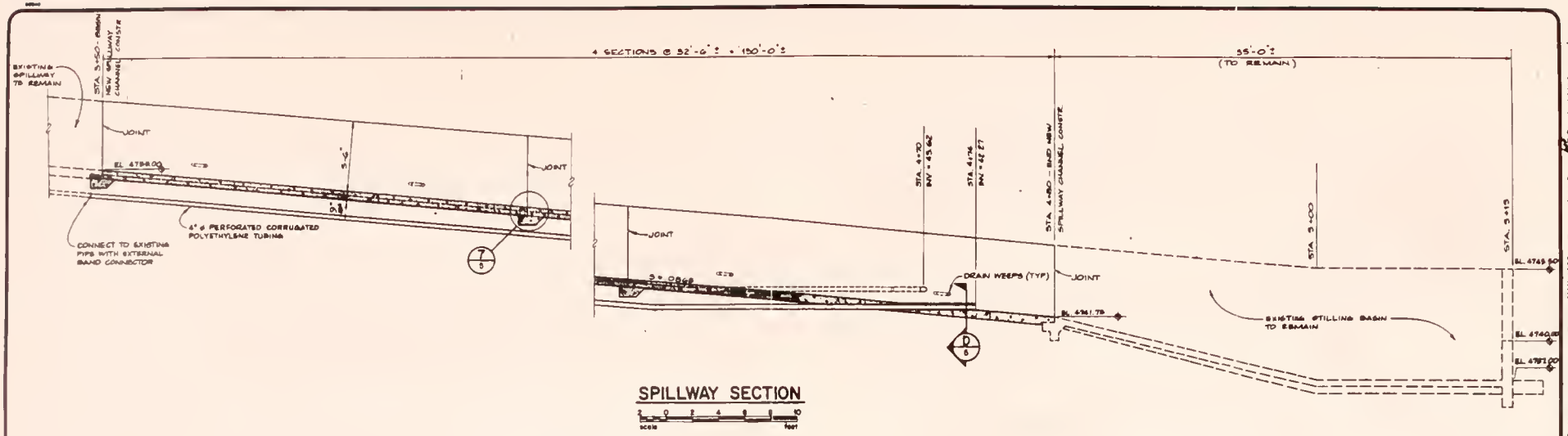
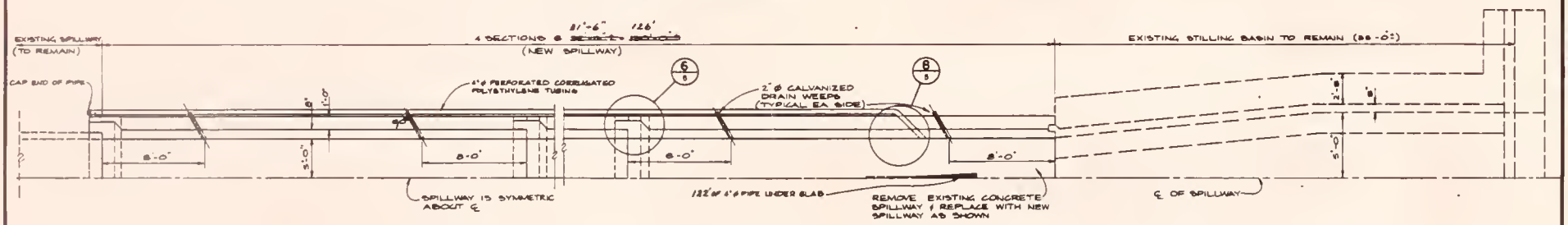
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

Sheet No 4 of 6



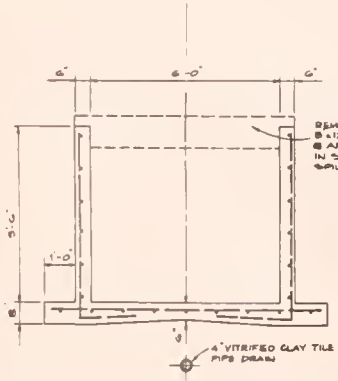
SPILLWAY SECTION

scale 0 1 2 4 8 feet


EXISTING SPILLWAY (TO REMAIN)
4 SECTIONS @ 81'-6" = 326'
(NEW SPILLWAY)
EXISTING STILLING BASIN TO REMAIN (55'-0")
CAP END OF PIPE
4" ø PERFORATED CORRUGATED POLYETHYLENE TUBING
2" ø GALVANIZED DRAIN WEEPS (TYPICAL EA SIDE)
8'-0"
5'-0"
SPILLWAY IS SYMMETRIC ABOUT ℄
132'-0" 4" ø PIPE UNDER SLAB
REMOVE EXISTING CONCRETE SPILLWAY & REPLACE WITH NEW SPILLWAY AS SHOWN
℄ OF SPILLWAY

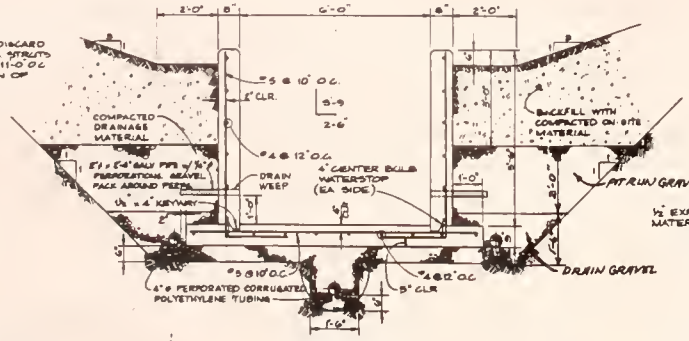
SPILLWAY PLAN
(HALF PLAN)

scale 0 2 4 8 feet



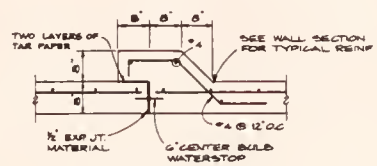
SECTION
EXISTING CHANNEL TO BE REPLACED

scale 0 1 2 3 4 8 feet



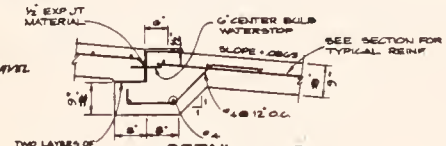
SECTION
NEW CHANNEL, STA. 3+50 to STA. 4+80

scale 0 1 2 4 8 feet



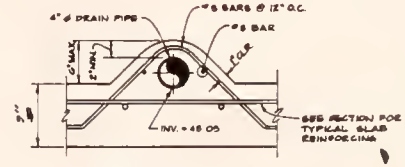
DETAIL 6/5
WALL JOINT

scale 0 1 2 feet



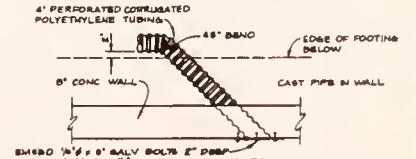
DETAIL 7/5
FLOOR JOINT

scale 0 1 2 feet



SECTION 5/5
PIPE

scale 0 1 2 feet


4" PERFORATED CORRUGATED POLYETHYLENE TUBING
48" BAND
EDGE OF FOOTING BELOW
8" CONC. WALL
CAST PIPE IN WALL
EMBED ¾"ø x 8" GALV. BOLTS 2" DEEP IN CONC. & FASTEN ½" GALV. HARDWARE CLOTH OVER OPENING

DETAIL 8/5
PIPE

scale 0 1 2 3 feet

MARTINSDALE DAM
REHABILITATION PROJECT

EAST DAM SPILLWAY PLAN, SECTION & DETAILS

Project No. 88097.190 I.D. No. Date MAY 1988 Designed KB Drawn BAS Checked KJE Approved

No.	Revision	By	Date

HKM ASSOCIATES
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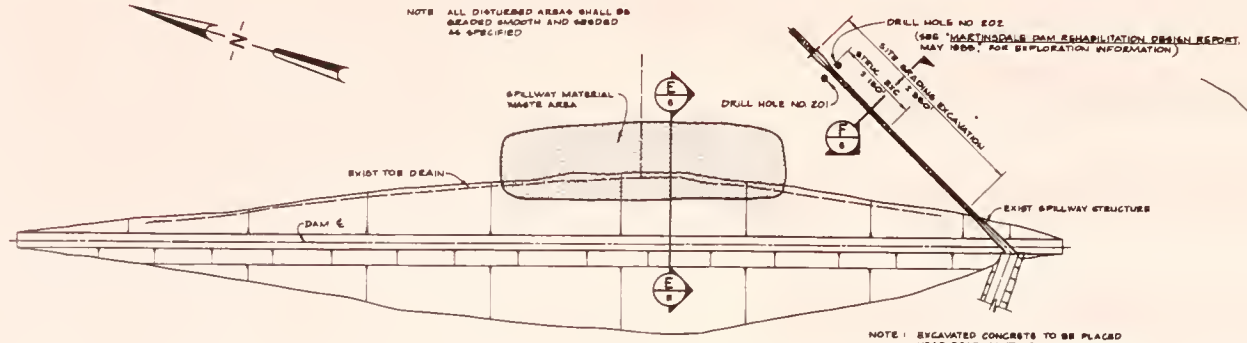
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

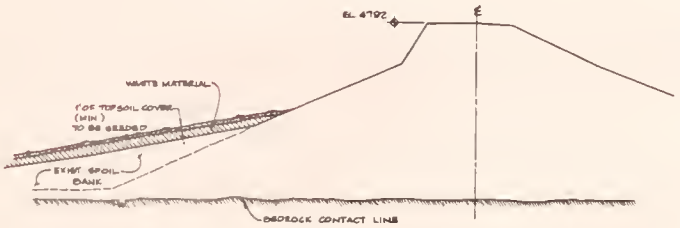
Sheet No. 5 of 8

AS BUILT 5-214-101


NOTE ALL DISTURBED AREAS SHALL BE GRADED SMOOTH AND SEEDED AS SPECIFIED
DRILL HOLE NO E02
(SEE 'MARTINSDALE DAM REHABILITATION DESIGN REPORT, MAY 1986,' FOR EXPLORATION INFORMATION)
SITE GRADING EXCAVATION
STRUC. EXC. = 2,800
= 1,100
SPILLWAY MATERIAL WASTE AREA
DRILL HOLE NO. E01
EXIST TOE DRAIN
DAM ℄
EXIST SPILLWAY STRUCTURE
NOTE : EXCAVATED CONCRETE TO BE PLACED NEAR ROAD, SOUTH EAST OF NORTH DAM ON BOTTOM AND THEN COVERED WITH OVERSIZE STONE AND LARGE BOULDERS EXCAVATED FROM DRAIN TRENCHES

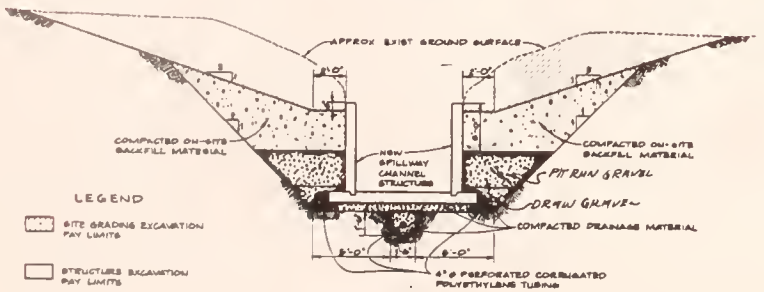
EAST DAM PLAN VIEW

SCALE 100 0 100 200 FEET



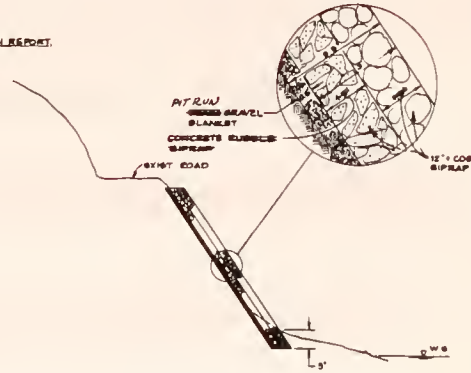
SECTION
EAST DAM WASTE AREA (E 8)

SCALE 20 0 20 40 FEET

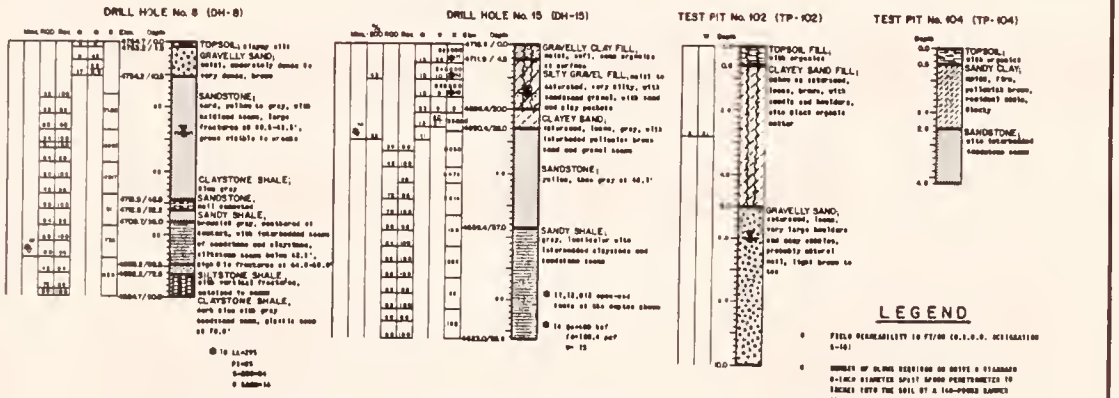


SECTION
SPILLWAY EXCAVATION (F 9)

SCALE 0 2 4 6 8 10 FEET



SECTION
NORTH DAM AREA RIPRAP (G 9)
NOT TO SCALE


DRILL HOLE No. 8 (DH-8)
DRILL HOLE No. 15 (DH-15)
TEST PIT No. 102 (TP-102)
TEST PIT No. 104 (TP-104)
TOPSOIL; clayey silt
GRAVELLY SAND; moist, moderately dense to very dense, brown
SANDSTONE; hard, yellow to gray, silt laminated seams, large fractures at 20.0-41.5', generally stable to unstable
CLAYSTONE SHALE; olive gray
SANDSTONE; well cemented
SANDY SHALE; broadly gray, mottled of siltstone, with interbedded seams of sandstone and claystone, siltstone seams below 62.1', edge to fractures at 64.0-68.0'
SILTSTONE SHALE; silty, vertical fractures, sandstone to seams
CLAYSTONE SHALE; dark olive with gray sandstone seams, plastic seam at 76.0'
GRAVELLY CLAY FILL; moist, soft, some organics at surface
SILTY GRAVEL FILL; moist to saturated, very silty, with sandstone gravel, with sand and clay pockets
CLAYEY SAND; saturated, loose, gray, with interbedded yellowish brown sand and gravel seams
SANDSTONE; yellow, then gray at 68.3'
SANDY SHALE; gray, locally silty, interbedded siltstone and sandstone seams
TOPSOIL; with organics
CLAYEY SAND FILL; moist to saturated, loose, brown, with cobbles and boulders, also black organic matter
GRAVELLY SAND; saturated, loose, very large boulders and some cobbles, primarily natural matt, light brown to tan
TOPSOIL; silty organics
SANDY CLAY; medium, firm, yellowish brown, residual shale, blocky
SANDSTONE; silty interbedded sandstone seams

NORTH DAM LOGS OF EXPLORATION HOLES

LEGEND

- ø FIELD PERMEABILITY IN FT/DAY (U.S.B.R. DESIGNATION E-18)
- # NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD 2-INCH DIAMETER SPLIT SPOON PENETROMETER TO INCHES INTO THE SOIL BY A 140-POUND HAMMER DROPPING FREELY A DISTANCE OF 30 INCHES
- W WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)
- Dens. DENSITY (PERCENT)
- DEF ONE-DIMENSIONAL DEFORMATION (PERCENT)
- 0.074 PERCENT OF SOIL PASSING THE NO. 200 SIEVE
- PI PLASTIC INDEX (PERCENT)
- LL LIQUID LIMIT (PERCENT)
- Qu COMPRESSION OF UNCONFINED COMPRESSION (T/FT²)
- DD DRY DENSITY (LBS. PER CU. FT.)
- U UNDISTURBED SAMPLE
- B BAG SAMPLE
- ▼ RECORDED WATER LEVEL (DATE OF READING, HOURS)

VERTICAL SCALES: DRILL HOLE LOGS: 1"=20' SURVEY: ELEVATIONS ARE MSL DATUM
PIT LOGS: 1"=4'

E37

AS BUILT 5-214-102

HKM ASSOCIATES
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Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

Project No. 84087.10 10 Ng Date MAY 1986 Designed JT Drawn MC Checked RF Approved

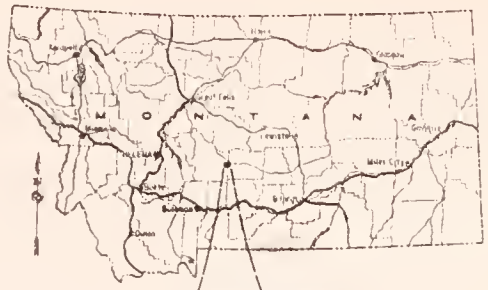
No	Revision	By	Date

MARTINSDALE DAM
REHABILITATION PROJECT
EAST DAM SITE GRADING PLAN & SECTIONS and NORTH DAM AREA RIPRAP SECTION & LOGS OF EXPLORATION HOLES

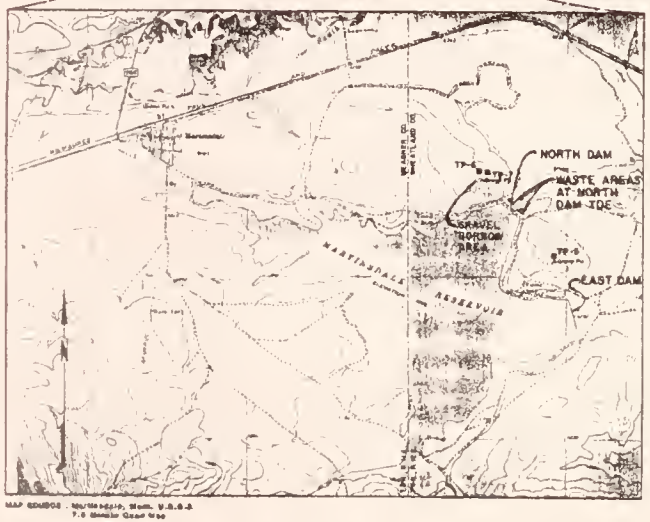
Sheet No 6 of 9

CONSTRUCTION PLANS
OF
NORTH DAM DRAIN SYSTEM MODIFICATIONS
MARTINSDALE DAM
DAM REHABILITATION PROJECT

MEAGHER and WHEATLAND COUNTIES, MONTANA



LOCATION MAP



VICINITY MAP

Prepared for :

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
WATER RESOURCES DIVISION, ENGINEERING BUREAU 1520 EAST 6th, HELENA, MT 59620 (406) 444-6646

And

UPPER MUSSELSHELL WATER USERS ASSOCIATION
MARTINSDALE, MONTANA

Prepared by :

HKM ASSOCIATES
ENGINEERS·PLANNERS
Airport Industrial Park
P.O Box 31318
Billings, Montana 59107
(406) 245-6364

HKM Proj. No. 8M087.120
AUGUST 1987

INDEX OF DRAWINGS

SHEET NO.	TITLE
1.	COVER SHEET
2.	NORTH DAM DRAIN SYSTEM MODIFICATIONS, PLAN and PROFILE
3.	DETAILS

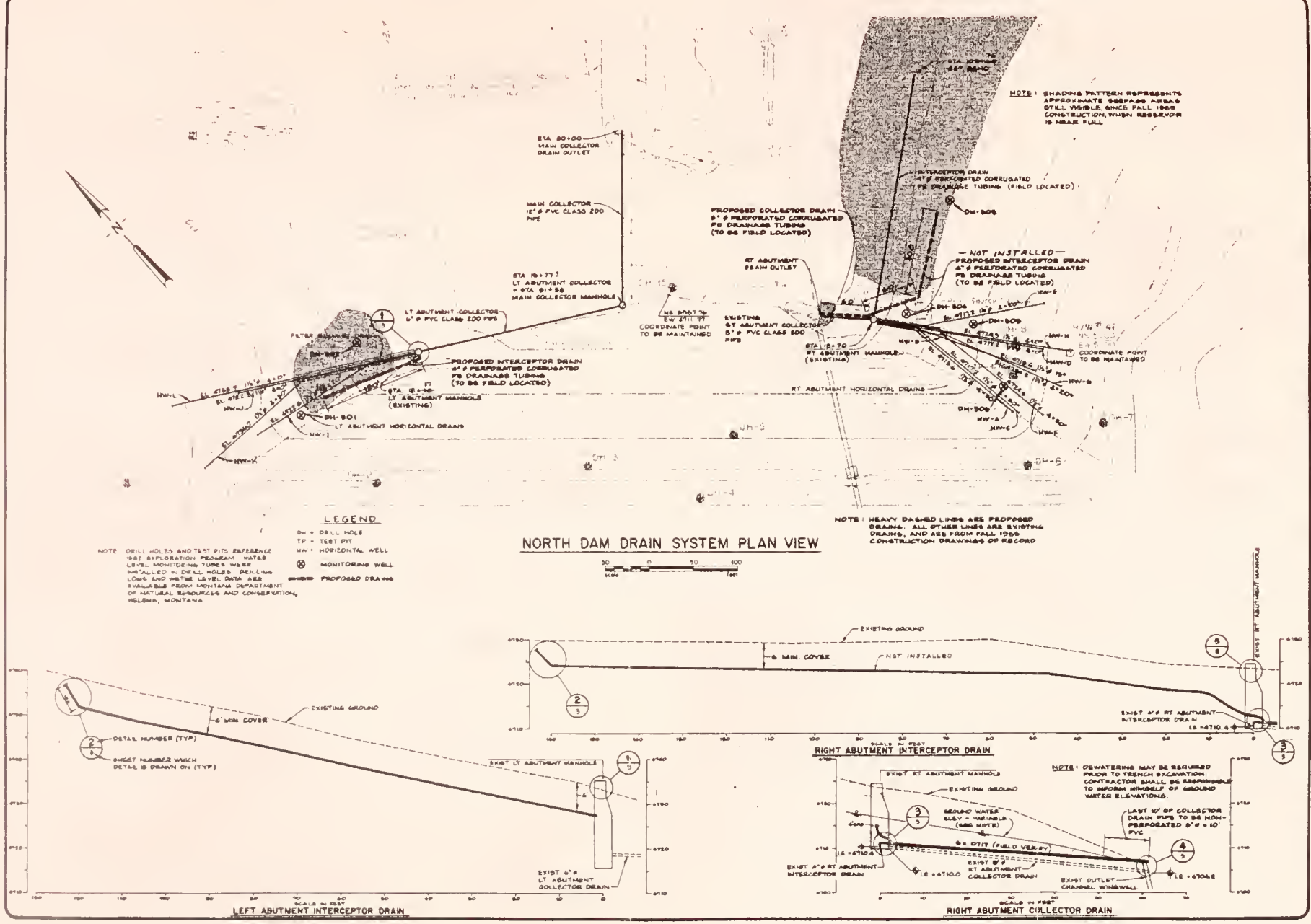
PRINCIPAL IN CHARGE, P.E., 19606

For design questions call HKM :
PROJECT ENGINEER, P.E., 8611E

Approved by :
CHIEF, ENGINEERING BUREAU
MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

Sheet No 1 of 3

5-214-110


NOTE: SHADING PATTERN REPRESENTS APPROXIMATE SEEPAGE AREAS STILL VISIBLE, SINCE FALL 1965 CONSTRUCTION, WHEN RESERVOIR IS NEAR FULL
STA 80+00 MAIN COLLECTOR DRAIN OUTLET
MAIN COLLECTOR 18" ϕ PVC CLASS 200 PIPE
STA 79+77.2 LT ABUTMENT COLLECTOR = STA 81+58 MAIN COLLECTOR MANHOLE
LT ABUTMENT COLLECTOR 6" ϕ PVC CLASS 200 PIPE
FILTER DRAINAGE
PROPOSED INTERCEPTOR DRAIN 6" ϕ PERFORATED CORRUGATED FB DRAINAGE TUBING (TO BE FIELD LOCATED)
STA 78+00 LT ABUTMENT MANHOLE (EXISTING)
DH-801
LT ABUTMENT HORIZONTAL DRAINS
HW-L
HW-J
HW-K
HW-I
NB 8967.7 E 4711 FT
COORDINATE POINT TO BE MAINTAINED
EXISTING 6" LT ABUTMENT COLLECTOR 6" ϕ PVC CLASS 200 PIPE
PROPOSED COLLECTOR DRAIN 6" ϕ PERFORATED CORRUGATED FB DRAINAGE TUBING (TO BE FIELD LOCATED)
INTERCEPTOR DRAIN 6" ϕ PERFORATED CORRUGATED FB DRAINAGE TUBING (FIELD LOCATED)
DH-808
RT ABUTMENT DRAIN OUTLET
— NOT INSTALLED — PROPOSED INTERCEPTOR DRAIN 6" ϕ PERFORATED CORRUGATED FB DRAINAGE TUBING (TO BE FIELD LOCATED)
DH-806
DH-805
HW-E
HW-F
HW-G
HW-H
HW-D
COORDINATE POINT TO BE MAINTAINED
STA 118+70 RT ABUTMENT MANHOLE (EXISTING)
HW-B
RT ABUTMENT HORIZONTAL DRAINS
DH-809
HW-A
HW-C
HW-E
DH-7
DH-6
DH-5
DH-4
DH-3
NOTE: HEAVY DASHED LINES ARE PROPOSED DRAINS. ALL OTHER LINES ARE EXISTING DRAINS, AND ARE FROM FALL 1965 CONSTRUCTION DRAWINGS OF RECORD
LEGEND
DH = DRILL HOLE
TP = TEST PIT
HW = HORIZONTAL WELL
MONITORING WELL
PROPOSED DRAINS
NOTE: DRILL HOLES AND TEST PITS REFERENCE 1982 EXPLORATION PROGRAM. WATER LEVEL MONITORING TUBES WERE INSTALLED IN DRILL HOLES. DRILLING LOGS AND WATER LEVEL DATA ARE AVAILABLE FROM MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION, HELENA, MONTANA
NORTH DAM DRAIN SYSTEM PLAN VIEW
50 0 50 100
SCALE IN FEET
EXISTING GROUND
6' MIN. COVER
NOT INSTALLED
EXIST 6" ϕ RT ABUTMENT INTERCEPTOR DRAIN LE = 4710.4
EXIST RT ABUTMENT MANHOLE
RIGHT ABUTMENT INTERCEPTOR DRAIN
DETAIL NUMBER (TYP)
SHEET NUMBER WHICH DETAIL IS DRAWN ON (TYP)
EXIST LT ABUTMENT MANHOLE
EXIST 6" ϕ LT ABUTMENT COLLECTOR DRAIN
LEFT ABUTMENT INTERCEPTOR DRAIN
EXIST RT ABUTMENT MANHOLE
GROUND WATER ELEV = VARIABLE (SEE NOTE)
6" ± DTIT (FIELD VERIFY)
LE = 4710.4
EXIST 6" ϕ RT ABUTMENT INTERCEPTOR DRAIN
LE = 4710.0
EXIST 8" ϕ RT ABUTMENT COLLECTOR DRAIN
LAST 10' OF COLLECTOR DRAIN PIPE TO BE NON-PERFORATED 6" ϕ x 10' PVC
EXIST OUTLET CHANNEL W/HEADWALL
LE = 4704.8
NOTE: DEWATERING MAY BE REQUIRED PRIOR TO TRENCH EXCAVATION. CONTRACTOR SHALL BE RESPONSIBLE TO INFORM HIMSELF OF GROUND WATER ELEVATIONS.
RIGHT ABUTMENT COLLECTOR DRAIN

Project No. 8982.338 I.D. No

Date 4/88 Designed by JJC Checked by Approved

No	Revision	By	Date
1	COMPLETED DRAWING	JJC	6-15-87
2	DRAWING ADDITIONS	JJC	9-29-87
3	AS BUILT	JJC	5-25-88

MARTINSDALE DAM REHABILITATION PROJECT

NORTH DAM DRAIN SYSTEM MODIFICATIONS PLAN AND PROFILES

HKM ASSOCIATES
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Billings, Montana 59107
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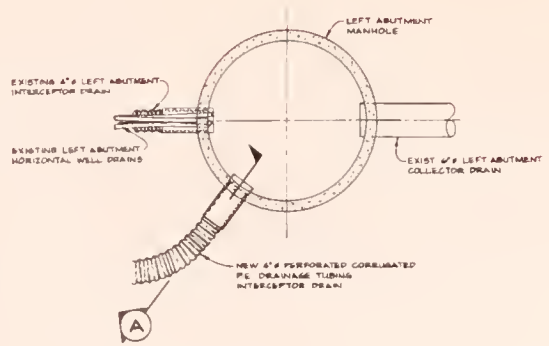
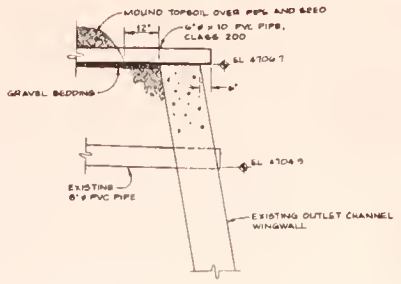
Sheet No 2 of 3

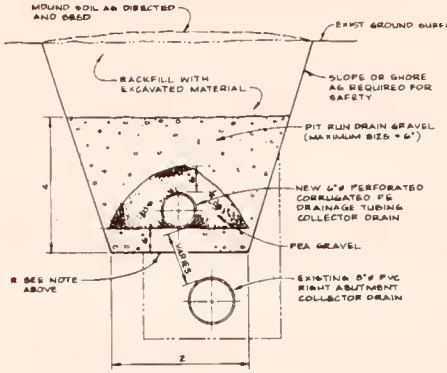
5-24-111


LEFT ABUTMENT MANHOLE
EXISTING 4"ø LEFT ABUTMENT INTERCEPTOR DRAIN
EXISTING LEFT ABUTMENT HORIZONTAL WELL DRAINS
EXIST 6"ø LEFT ABUTMENT COLLECTOR DRAIN
NEW 4"ø PERFORATED CORRUGATED PE DRAINAGE TUBING INTERCEPTOR DRAIN
A

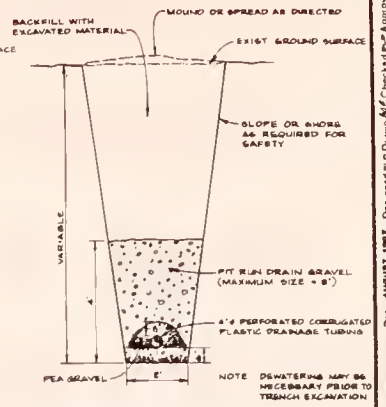
DETAIL
LEFT ABUTMENT MANHOLE (1)
NOT TO SCALE



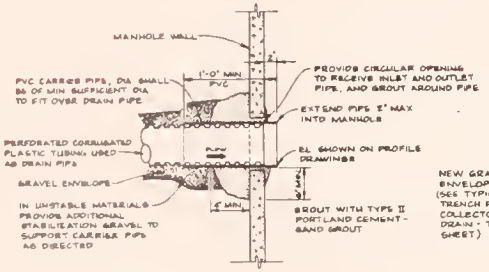
DETAIL
RIGHT ABUTMENT DRAIN OUTLET (4)
NOT TO SCALE


MOUND SOIL AS DIRECTED AND SEED
EXIST GROUND SURFACE
BACKFILL WITH EXCAVATED MATERIAL
SLOPE OR SHORE AS REQUIRED FOR SAFETY
PIT RUN DRAIN GRAVEL (MAXIMUM SIZE = 6")
NEW 6"ø PERFORATED CORRUGATED PE DRAINAGE TUBING COLLECTOR DRAIN
PEA GRAVEL
SEE NOTE ABOVE
EXISTING 8"ø PVC RIGHT ABUTMENT COLLECTOR DRAIN
4
2

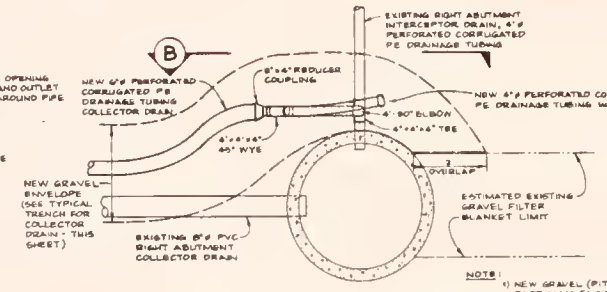
TYPICAL TRENCH
FOR COLLECTOR DRAIN
NOT TO SCALE


BACKFILL WITH EXCAVATED MATERIAL
MOUND OR SPREAD AS DIRECTED
EXIST GROUND SURFACE
SLOPE OR SHORE AS REQUIRED FOR SAFETY
VARIABLE
PIT RUN DRAIN GRAVEL (MAXIMUM SIZE = 6")
6"ø PERFORATED CORRUGATED PLASTIC DRAINAGE TUBING
PEA GRAVEL
2'
NOTE DEWATERING MAY BE NECESSARY PRIOR TO TRENCH EXCAVATION

TYPICAL TRENCH
FOR INTERCEPTOR DRAIN
NOT TO SCALE

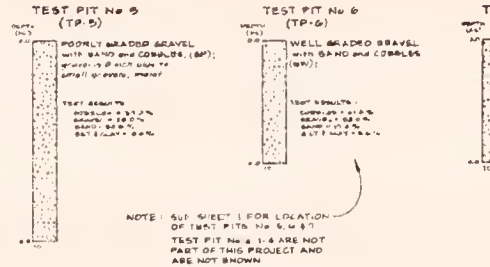

MANHOLE WALL
PVC CARRIER PIPE, DIA SHALL BE OF MIN SUFFICIENT DIA TO FIT OVER DRAIN PIPE
1'-0" MIN PVC
PROVIDE CIRCULAR OPENING TO RECEIVE INLET AND OUTLET PIPE, AND GROUT AROUND PIPE
EXTEND PIPE 2" MAX INTO MANHOLE
PERFORATED CORRUGATED PLASTIC TUBING USED AS DRAIN PIPE
FLOW
EL SHOWN ON PROFILE DRAWINGS
GRAVEL ENVELOPE
4" MIN
IN UNSTABLE MATERIALS PROVIDE ADDITIONAL STABILIZATION GRAVEL TO SUPPORT CARRIER PIPE AS DIRECTED
GROUT WITH TYPE II PORTLAND CEMENT-SAND GROUT

SECTION
INTERCEPTOR DRAIN TO MANHOLE CONNECTION (A)
NOT TO SCALE

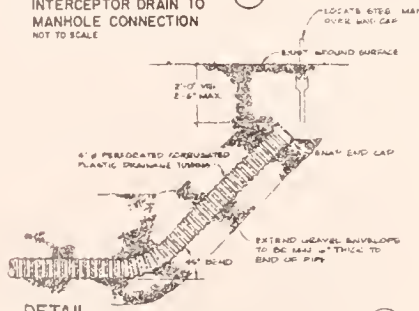

B
EXISTING RIGHT ABUTMENT INTERCEPTOR DRAIN, 4" PERFORATED CORRUGATED PE DRAINAGE TUBING
NEW 6"ø PERFORATED CORRUGATED PE DRAINAGE TUBING COLLECTOR DRAIN
6"x4" REDUCER COUPLING
NEW 4"ø PERFORATED CORRUGATED PE DRAINAGE TUBING WITH CAP
4"-90° ELBOW
4"x4"x6" TEE
6"x4"x6" 45° WYE
2' OVERLAP
NEW GRAVEL ENVELOPE (SEE TYPICAL TRENCH FOR COLLECTOR DRAIN - THIS SHEET)
ESTIMATED EXISTING GRAVEL FILTER BLANKET LIMIT
EXISTING 8"ø PVC RIGHT ABUTMENT COLLECTOR DRAIN

DETAIL
RIGHT ABUTMENT MANHOLE (3)
NOT TO SCALE

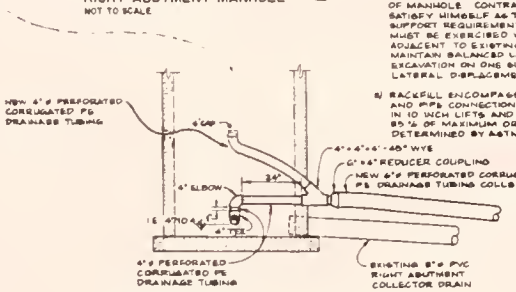
NOTE:
1) NEW GRAVEL (PITRUN) ENVELOPE SHALL PARTIALLY ENCIRCLE MANHOLE AND BE IN CONTACT WITH EXISTING GRAVEL FILTER BLANKET.
2) CONTRACTOR SHALL BE RESPONSIBLE TO MAINTAIN VERTICAL ALIGNMENT OF MANHOLE. CONTRACTOR SHALL SATISFY HIMSELF AS TO LATERAL SUPPORT REQUIREMENTS. CAUTION MUST BE EXERCISED WHEN EXCAVATING ADJACENT TO EXISTING MANHOLE TO MAINTAIN BALANCED LATERAL SUPPORT. EXCAVATION ON ONE SIDE ONLY COULD CAUSE LATERAL DISPLACEMENT OF MANHOLE.
3) BACKFILL ENCOMPASSING MANHOLE AND PIPE CONNECTION SHALL BE PLACED IN 10 INCH LIFTS AND COMPACTED TO 85 % OF MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 698.


TEST PIT No 5 (TP-5)
POORLY GRADED GRAVEL WITH SAND AND COBBLES, (GP);
TEST RESULTS
TEST PIT No 6 (TP-6)
WELL GRADED GRAVEL WITH SAND AND COBBLES (GW);
TEST RESULTS
TEST PIT No. 7 (TP-7)
WELL GRADED GRAVEL WITH SAND AND COBBLES, (GW);
TEST RESULTS
NOTE: SEE SHEET 1 FOR LOCATION OF TEST PITS No 5, 6 & 7
TEST PIT No s 1-4 ARE NOT PART OF THIS PROJECT AND ARE NOT SHOWN

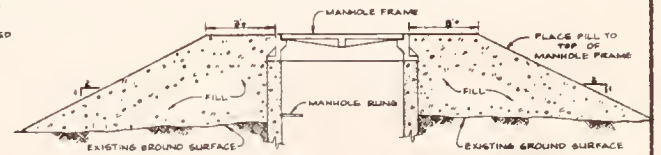
LOGS OF TEST PITS


LOCATE STEEL MARKER OVER WATER CAP
EXIST GROUND SURFACE
2'-0" MIN 2'-6" MAX
6"ø PERFORATED CORRUGATED PLASTIC DRAINAGE TUBING
6"ø END CAP
EXTEND GRAVEL ENVELOPE TO BE MIN 6" THICK TO END OF PIPE
45° BEND

DETAIL
BLANKET DRAIN & INTERCEPTOR DRAIN END (2)
NOT TO SCALE



SECTION
INTERCEPTOR DRAINS TO COLLECTOR DRAIN CONNECTION (B)
NOT TO SCALE



DETAIL
FILL AT EXISTING MANHOLES (5)
NOT TO SCALE

No	Revision	By	Date
1	COMPUTER DRAWING	AM	8-19-91
2	DRAWING CORRECTIONS	AM	8-23-91
3	AS-BUILT	AM	9-23-92

Date AUGUST 1991 Designed PS Drawn AS Checked PS Approved

I.D. No

Project No 88047.389

MARTINSDALE DAM
REHABILITATION PROJECT
NORTH DAM DRAIN SYSTEM MODIFICATIONS
DETAILS

HKM ASSOCIATES
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Billings, Montana 59107
Branch Offices
• Libby, Montana
• Sheridan, Wyoming

Sheet No 3 of 3

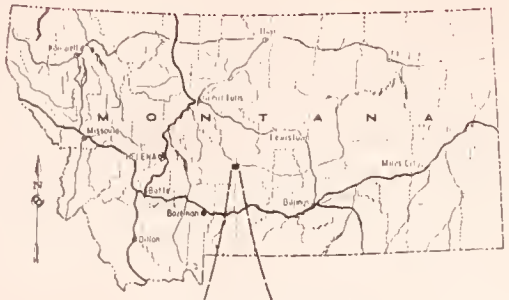
5-214-112

CONSTRUCTION PLANS
OF
EAST DAM AUXILIARY SPILLWAY

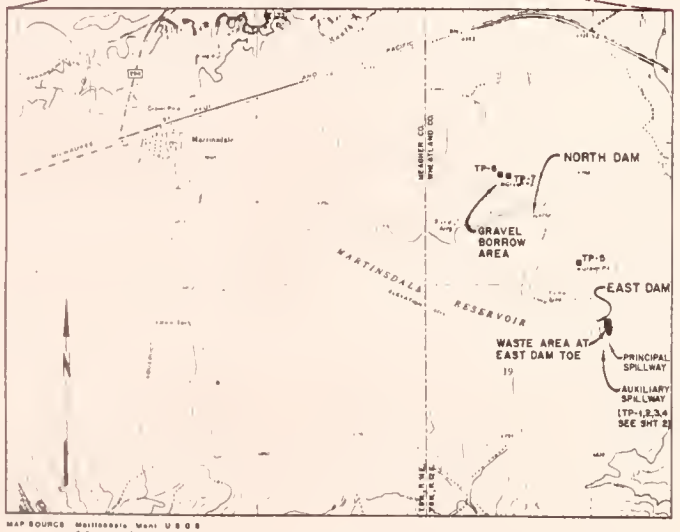
MARTINSDALE DAMS

DAM REHABILITATION PROJECT

MEAGHER and WHEATLAND COUNTIES, MONTANA



LOCATION MAP



MAP SOURCE Martinsdale, Mont. USGS 7.5 Minute Quad Map

VICINITY MAP

3000 0 2000 4000
Scale in feet

Prepared for :

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
WATER RESOURCES DIVISION, ENGINEERING BUREAU 1520 EAST 6th, HELENA, MT 59620 (406) 444-6646

And

UPPER MUSSELSHELL WATER USERS ASSOCIATION
MARTINSDALE, MONTANA

Prepared by :

HKM ASSOCIATES
ENGINEERS·PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
(406) 245-6354

HKM Proj. No. 8M087.120
SEPTEMBER 1988

INDEX OF DRAWINGS

SHEET NO.	TITLE
1.	COVER SHEET
2.	EAST DAM AUXILIARY SPILLWAY
3.	CROSS SECTIONS OF EAST DAM, AUXILIARY SPILLWAY

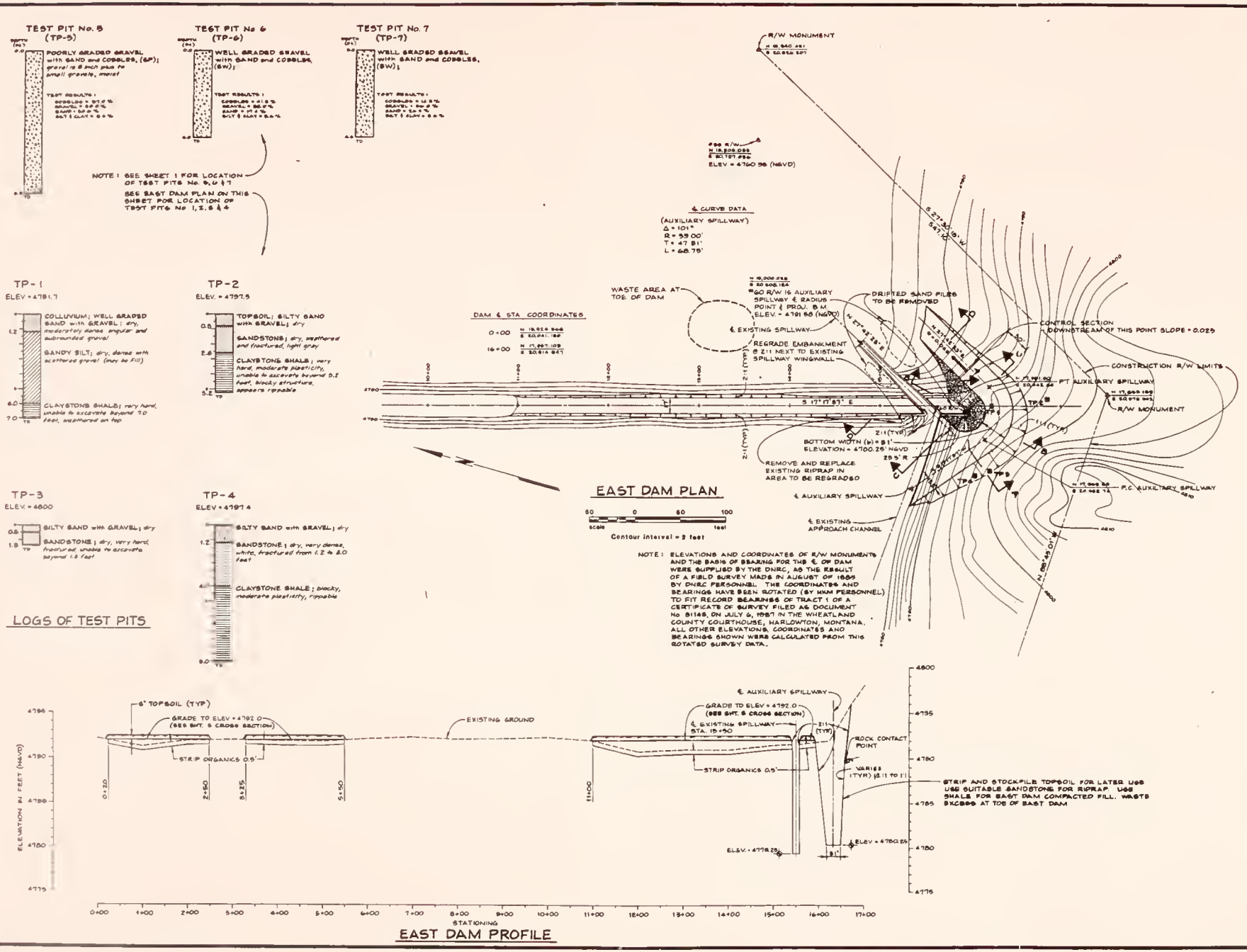
PRINCIPAL IN CHARGE, P.E., 1998E

For design questions call HKM :
PROJECT ENGINEER, P.E., 3355E

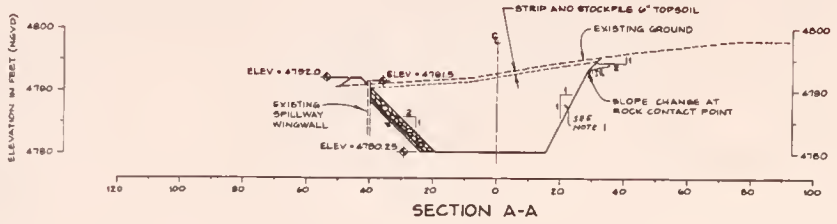
Approved by :
CHIEF, ENGINSERING BUREAU
MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

Sheet No 1 of 3

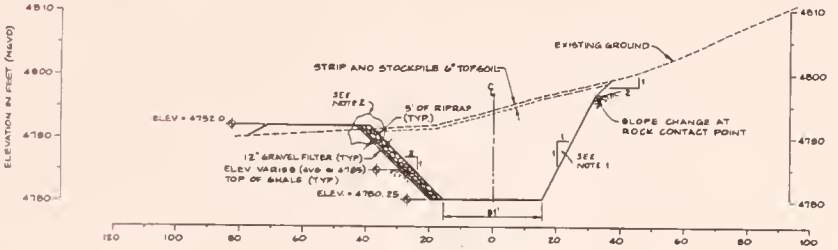
AS BUILT DRAWING E45


TEST PIT No. 5 (TP-5)
POORLY GRADED GRAVEL with SAND and COBBLES, (GP); gravel is 8 inch plus to small gravels, moist
TEST RESULTS:
COBBLES = 21.6 %
GRAVEL = 58.0 %
SAND = 18.4 %
SILT & CLAY = 2.0 %
TEST PIT No. 6 (TP-6)
WELL GRADED GRAVEL with SAND and COBBLES, (GW);
TEST RESULTS:
COBBLES = 41.8 %
GRAVEL = 36.0 %
SAND = 19.4 %
SILT & CLAY = 2.8 %
TEST PIT No. 7 (TP-7)
WELL GRADED GRAVEL with SAND and COBBLES, (GW);
TEST RESULTS:
COBBLES = 41.8 %
GRAVEL = 36.0 %
SAND = 20.2 %
SILT & CLAY = 2.0 %
NOTE: SEE SHEET 1 FOR LOCATION OF TEST PITS No. 5, 6 & 7
SEE EAST DAM PLAN ON THIS SHEET FOR LOCATION OF TEST PITS No 1, 2, 3 & 4
TP-1
ELEV. = 4781.7
COLLUVIUM; WELL GRADED SAND with GRAVEL; dry, moderately dense, angular and subrounded gravel
SANDY SILT; dry, dense with scattered gravel (may be Fill)
CLAYSTONE SHALE; very hard, unable to excavate beyond 7.0 feet, weathered on top
TP-2
ELEV. = 4797.5
TOPSOIL; SILTY SAND with GRAVEL; dry
SANDSTONE; dry, weathered and fractured, light gray
CLAYSTONE SHALE; very hard, moderate plasticity, unable to excavate beyond 5.2 feet, blocky structure, appears rippable
TP-3
ELEV. = 4800
SILTY SAND with GRAVEL; dry
SANDSTONE; dry, very hard, fractured, unable to excavate beyond 1.8 feet
TP-4
ELEV. = 4797.4
SILTY SAND with GRAVEL; dry
SANDSTONE; dry, very dense, white, fractured from 1.2 to 8.0 feet
CLAYSTONE SHALE; blocky, moderate plasticity, rippable
LOGS OF TEST PITS
R/W MONUMENT
N 18,840.481
E 20,852.527
℄ R/W
N 18,808.088
E 20,727.956
ELEV = 4760.58 (NGVD)
℄ CURVE DATA
(AUXILIARY SPILLWAY)
Δ = 101°
R = 39.00'
T = 47.81'
L = 68.75'
WASTE AREA AT TOE OF DAM
DAM ℄ STA COORDINATES
0+00
N 18,852.866
E 20,041.188
16+00
N 17,997.109
E 20,816.847
N 19,000.928
E 20,908.184
60 R/W IS AUXILIARY SPILLWAY ℄ RADIUS POINT & PROJ. B.M.
ELEV. = 4791.88 (NGVD)
℄ EXISTING SPILLWAY
REGRADE EMBANKMENT @ 2:1 NEXT TO EXISTING SPILLWAY WINGWALL
DRIFTED SAND PILES TO BE REMOVED
CONTROL SECTION DOWNSTREAM OF THIS POINT SLOPE = 0.025
CONSTRUCTION R/W LIMITS
PT AUXILIARY SPILLWAY
R/W MONUMENT
P.C. AUXILIARY SPILLWAY
BOTTOM WIDTH (b) = 81'
ELEVATION = 4780.25' NGVD
255' R
REMOVE AND REPLACE EXISTING RIPRAP IN AREA TO BE REGRADED
℄ AUXILIARY SPILLWAY
℄ EXISTING APPROACH CHANNEL
EAST DAM PLAN
50 0 50 100
Scale feet
Contour interval = 2 feet
NOTE: ELEVATIONS AND COORDINATES OF R/W MONUMENTS AND THE BASIS OF BEARING FOR THE ℄ OF DAM WERE SUPPLIED BY THE DNRC, AS THE RESULT OF A FIELD SURVEY MADE IN AUGUST OF 1985 BY DNRC PERSONNEL. THE COORDINATES AND BEARINGS HAVE BEEN ROTATED (BY HKM PERSONNEL) TO FIT RECORD BEARINGS OF TRACT 1 OF A CERTIFICATE OF SURVEY FILED AS DOCUMENT No 81148, ON JULY 6, 1987 IN THE WHEATLAND COUNTY COURTHOUSE, HARLOWTON, MONTANA. ALL OTHER ELEVATIONS, COORDINATES AND BEARINGS SHOWN WERE CALCULATED FROM THIS ROTATED SURVEY DATA.
6" TOPSOIL (TYP)
GRADE TO ELEV = 4792.0 (SEE SHT. 5 CROSS SECTION)
STRIP ORGANICS 0.5'
EXISTING GROUND
℄ AUXILIARY SPILLWAY
GRADE TO ELEV = 4792.0 (SEE SHT. 5 CROSS SECTION)
℄ EXISTING SPILLWAY STA. 15+90
ROCK CONTACT POINT
VARIES (TYP) 1/2:1 TO 1:1
STRIP AND STOCKPILE TOPSOIL FOR LATER USE
USE SUITABLE SANDSTONE FOR RIPRAP USE SHALE FOR EAST DAM COMPACTED FILL. WASTE EXCESS AT TOE OF EAST DAM
ELEV. = 4778.25
ELEV = 4780.25
ELEVATION IN FEET (NGVD)
STATIONING
EAST DAM PROFILE
MARTINSDALE DAMS
DAM REHABILITATION PROJECT
EAST DAM AUXILIARY SPILLWAY
Project No. 8M087.120 ID No. Date SEPT. 1988 Designed BF Drawn MC Checked JT Approved
No 1 2 Revision By Date
HKM ASSOCIATES
ENGINEERS·PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming
Sheet No 2 of 3

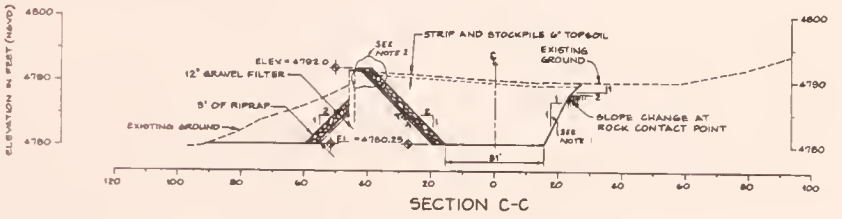
AS BUILT DRAWING E47



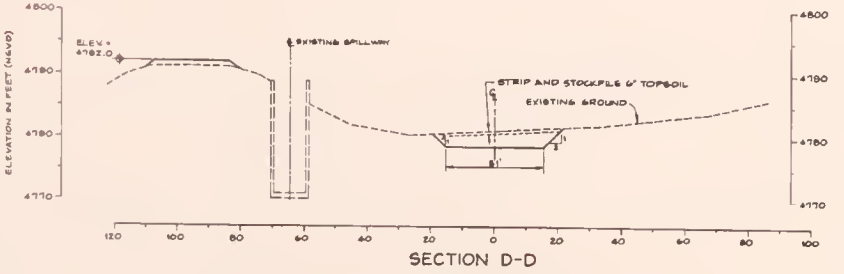
SECTION A-A



SECTION B-B

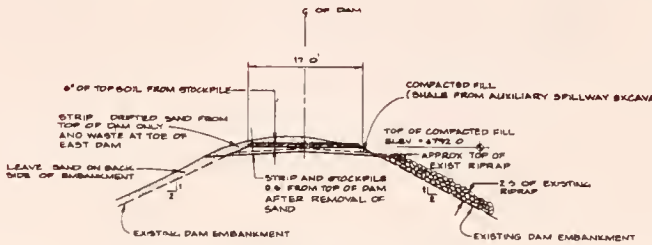


SECTION C-C



SECTION D-D

AUXILIARY SPILLWAY CROSS SECTIONS


℄ OF DAM
17.0'
6" OF TOPSOIL FROM STOCKPILE
COMPACTED FILL (SHALE FROM AUXILIARY SPILLWAY EXCAVATION)
STRIP DRIFTED SAND FROM TOP OF DAM ONLY AND WASTE AT TOE OF EAST DAM
TOP OF COMPACTED FILL ELEV. = 4792.0
APPROX TOP OF EXIST. RIPRAP
2:1 OF EXISTING RIPRAP
LEAVE SAND ON BACK SIDE OF EMBANKMENT
STRIP AND STOCKPILE 0.5 FROM TOP OF DAM AFTER REMOVAL OF SAND
EXISTING DAM EMBANKMENT
EXISTING DAM EMBANKMENT

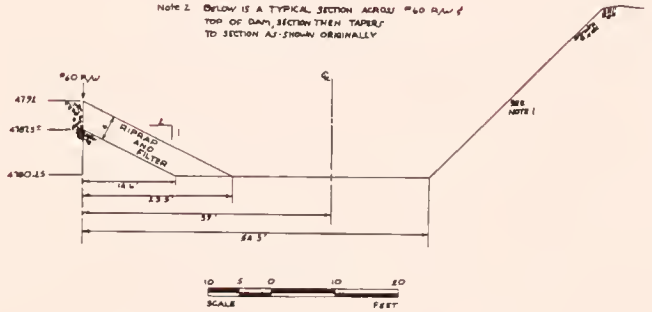
TYPICAL EAST DAM CROSS SECTION

STA. 0+20 TO STA. 2+80
STA. 3+25 TO STA. 8+80
STA. 11+00 TO STA. 18+00

10 5 0 10 20
scale feet

Note 1 SLOPE VARIES FROM APPROX ½ : 1 TO 1 : 1

Note 2 BELOW IS A TYPICAL SECTION ACROSS 60 R/W ℄ TOP OF DAM, SECTION THEN TAPERS TO SECTION AS SHOWN ORIGINALLY



Project No 9M087.120 I.D. No Date SEPT. 1988 Designed JH Drawn JH Checked JC Approved

No	Revision	By	Date
1	REVISION AS SHOWN	JH	9-9-88
2	ORIGINAL DESIGN REVISED SECTION REMOVED	JH	9-9-88

MARTINSDALE DAMS
DAM REHABILITATION PROJECT

CROSS SECTIONS of EAST DAM, AUXILIARY SPILLWAY

HKM ASSOCIATES
ENGINEERS-PLANNERS
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Sheet No 3 of 3

AS BUILT DRAWING E49